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Physically Active Academic Lessons and On-task Behavior in Preadolescent Children: Effects of Physical Activity Intensity

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Physically Active Academic Lessons and On-task Behavior in Preadolescent Children: Effects of Physical Activity Intensity

by

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Physically Active Academic Lessons and On-task Behavior in Preadolescent Children: Effects of Physical Activity Intensity

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Past research has shown classroom lessons incorporating physical activity (10-15 minutes in duration) to improve on-task behavior in children (Mahar, 2006; Grieco, Bartholomew & Jowers, 2009). However, no study to date has examined the levels of physical activity required to elicit this response. As such, the present study was designed to assess the effects of physically active, academic lessons of varying intensity, set in game-type format, on academic engagement of preadolescent children in the classroom setting. Time spent on-task (measured through direct observation) served as the primary outcome variable and assessed by means of a two (time: pre-, post-lesson) x four [condition: inactive lesson (physical activity control); sedentary academic game (interest control); low-to-moderate intensity physically active academic game; moderate-to-vigorous intensity physically active academic game] repeated measures design. Participants were third, fourth and fifth grade children from two elementary schools in central Texas (7 to 11 years of age). Physical activity was measured using Actigraph GT1M accelerometers (Fort Walton Beach, FL). Demographic data were collected for

each participant on gender, age, ethnicity, height and weight (BMI calculated). Results indicated that the students' TOT decreased significantly after a traditional seated control lesson. TOT did not change following the inactive control game. Thus, the competitive, seated game was sufficient to prevent the reduction in TOT that followed the traditional, seated control. In contrast, both physically active games were sufficient to increase TOT. Both had a significant increase in TOT relative to each control condition. In addition, the effect of the MVPA game was nearly three times the effect of the LMPA game.

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# CHAPTER 1
# INTRODUCTION

## PURPOSE

The present study assessed the effects of physically active academic lessons of varying intensity, set in game-type format, on the on-task behavior of preadolescent children in the classroom setting.

## BACKGROUND

Physically active academic lessons use movement in the teaching of core academic concepts in the classroom and are designed to increase physical activity among elementary school children without sacrificing academic time. These lessons provide 10- to 15-minute periods of physical activity during the regular education school day, i.e. outside of physical education and recess. Although the aim of these lessons is to provide exercise opportunities throughout the day, additional behavioral benefits have been found to occur.

In-class physical activity programs have shown an increase in students' time on-task (TOT) during subsequent sedentary lessons. TOT is an indicator of student engagement in academic content and is assessed observationally and quantified as percentage of time spent attending to the teacher-specified task. For example, participation in physically active lessons was found to increase children's TOT following an academic lesson taught through physical activity, compared with a control lesson (Mahar et al., 2006). These lessons consisted of actions such as students standing up from their desks and mimicking actions of a story (e.g., climbing an imaginary tree). Subsequent studies have built upon this concept using lessons that allow for a greater range of physical activities and variety of movement. Updated lessons incorporate actions such as running, jumping, sit-ups and push-ups, and are played in a larger area (moving desks to the periphery of the classroom or moving students outside).

Further results have indicated that physically active lessons provide a differential benefit for children classified as at-risk for overweight and as overweight. Student engagement, operationalized as time on-task (TOT), decreased significantly from pre- to post-lesson for all BMI categories following an inactive control lesson, with the reduction in TOT increasing with each level of BMI. Physically active lessons were found to provide a buffer for this reduction, with resulting in a similar, high level of TOT across all weight classifications (Grieco, Jowers, & Bartholomew, 2009).

Past protocols examining the physically active academic lesson-TOT response (Mahar et al., 2006; Grieco, Jowers, & Bartholomew, 2009) aimed to utilize physical activity at a moderate-to-vigorous level of intensity. Unfortunately, lesson-specific physical activity was not directly measured in these studies - leaving the actual dose of physical activity unknown. To maximize benefits afforded by active lessons, the intensity required to elicit the on-task response requires examination. Likewise, it may be that the games are no more beneficial than a break from focused, academic instruction – a possibility that has yet to be tested. If the benefit of these interventions is merely a break from instruction, then no physical activity is required to achieve the increase in time on task. The present study was designed to test this possibility and to assess the effects of physically active academic lessons of varying intensity on the on-task behavior of preadolescent children in the classroom setting.

To this end, 320 students completed one of four conditions: (1) inactive lesson (physical activity control); (2) sedentary academic game (interest control); (3) low-to-moderate intensity physically active academic game; and (4) moderate-to-vigorous intensity physically active academic game. The low-to-moderate intensity and moderate-to-vigorous intensity conditions were designed to capture the range of activity levels typically implemented during these games in classroom-based physical activity interventions. The inactive game was designed to provide a sedentary academic activity with a similar level of interest and/or distraction as the physically active lessons. The inactive control lesson was designed to mimic a traditional seated desk lesson. As such, the resulting data provides insight into the level of physical activity required to impact on-task behavior and, potentially, the mechanisms underlying the physically active lesson-TOT response.

## RESEARCH STUDY

### PURPOSE

The purpose of the current study is to examine the effects of physically active academic lessons of varying intensity, set in game-type format, on the on-task behavior of preadolescent children in the classroom setting.

### METHODS

Participants were 3rd, 4th and 5th grade students (aged 7-12 years) recruited from elementary schools in central Texas. Classes were randomly assigned to one of four lesson conditions: (1) inactive lesson (physical activity control); (2) sedentary academic game (interest control); (3) low-to-moderate intensity physically active academic game; and (4) moderate-to-vigorous intensity physically active academic game. TOT was measured during 15-minute classroom observations both prior to and following each of the four lesson conditions. Children were randomly assigned to condition by classroom, and observed both prior to and following the assigned condition. This resulted in a two (time: pre-, post-lesson) x four (lesson condition) mixed factorial design with repeated measures on the first factor. To reduce the impact of other activity, all observations were conducted on non-P.E. days and during the longest sedentary time possible. This method has been shown to be a valid measure in previous studies (Mahar et al., 2006; Grieco, Bartholomew & Jowers, 2009).

### HYPOTHESES

<u>Condition</u>

TOT was expected to vary according to condition, with effect sizes greatest for the moderate-to-vigorous intensity physically active academic game, followed by the low-to-moderate intensity physically active academic game, inactive academic game condition, and inactive classroom lesson, respectively. This was tested through the time by condition interaction using a 2 (time [pre- vs. post-observation] x condition [control lesson, control game, LMPA game, MVPA game]) repeated measures analysis of variance (RMANOVA) on percentage TOT. The predicted time by condition interaction was found. Simple effects were tested and effect sizes calculated to reflect the magnitude of effect. These were largely in-line with the hypothesized relationships.

BMI

BMI was expected to moderate the effect of lesson condition on TOT, such that a greater magnitude of effect would be observed for children at-risk and overweight. This was tested through a three-way (time [pre- vs. post-observation] x condition [control lesson, control game, LMPA game, MVPA game] x BMI category [normal, at-risk/overweight]) RMANOVA. Contrary to hypotheses, BMI category did not interact with either time or condition.

Physical Fitness

Physical fitness was expected to moderate lesson condition effects on TOT. This was analyzed using a three-way (time [pre- vs. post-observation] x condition [control lesson, control game, LMPA game, MVPA game] x fitness category [low, moderate, high]) RMANOVA. Contrary to hypotheses, fitness category did not interact with either condition or time.

Situational Interest

Interest in each lesson condition was expected to remain similar across game and rank slightly higher than the inactive control lesson. This was tested using a one-way ANOVA and yielded a significant main effect for interest by condition. Post hoc tests were conducted to determine differences in interest between conditions. Because of differing interest ratings between conditions, tests for moderation were conducted to further examine the effect of situational interest on the main outcome variable of TOT. Situational interest did not interact with either time or condition.

**LIMITATIONS**

In the current study, trained project staff implemented the lessons. The design was selected as an effort to control implementation across a large group of classes. As a result, the ability of teachers to implement these lessons in an intervention context was not tested. However, in our previous studies, teachers were trained and observed periodically throughout the study and fidelity to lesson protocol was acceptable and implementation rates were high, at 94%. Thus, trained teachers were able to conduct these lessons independently.

Other limitations include a one-time assessment of TOT and no assessment of behavioral problems. Multiple observations of the same class were thought to compromise already limited schedules, as the school district only granted approval for one observation per teacher. Similarly, the district would not release the data on or pertaining to behavioral problems, nor would it allow for administration of proxy surveys in the classroom. An additional limitation includes the ability to detect the moderating effects of BMI and fitness in this sample. Because these variables are so highly correlated, the power may be too low to detect moderation.

These data are also limited by the one-time assessment of post-intervention TOT. Both this study and our earlier work indicate that TOT is highly variable, dropping nearly 20 percentage points in 45 minutes for the control groups. Thus, an assessment of the decay in TOT following each intervention would have greatly enhanced the study. In addition, TOT is only important to the extent that it ultimately correlates with academic outcomes and learning. The present study does not assess these outcomes and the impact of these data must be interpreted with caution until such an outcome is reliably tested.

Finally, this study was designed to assess moderation by BMI. Unfortunately for the study (though fortunate for the participants) there were not a large number of children categorized as overweight. This lowered the power to test moderation. Although the observed effects did not suggest a significant pattern of effects, this remains a limitation until a more powerful assessment is utilized. Likewise, fitness was categorized. Although the power was sufficient, with a relatively even number of children in each category across conditions, the method of categorizing fitness was developed for this dissertation. It may be that the cut-offs for 3rd grade children were inappropriate and that the count of tests in the healthy fitness zone fails to accurately describe fitness in children. Although further validation is required, it was an effort to more fully utilize the FITNESSGRAM and the full meaning of fitness than has been attempted before.

**DELIMITATIONS**

Third, 4th and 5th grade children were selected for use in the implementation of physically active academic lessons because physical activity levels are known to decline during this time (Sun, Gao, Ransdell & Johnson, 2010; Trost et al., 2002). This age group is, therefore, an ideal point of intervention to increase physical activity levels among children. However, because this study was conducted on 3rd through 5th grade children, results may not generalize to other age groups. Results are further delimited to sedentary periods and the content area of language arts.

## SIGNIFICANCE OF STUDY

Modification of student engagement through use of physically active academic lessons has the potential to enhance learning by increasing student engagement during academic instruction time. The immediacy of these academic effects may serve to increase motivation among teachers to implement physically active lessons, which also moves children closer to obtaining the recommended amount of 60 minutes of daily MVPA (CDC, 2010). That is, by simply incorporating one, 15-minute physically active academic lesson into a child's day, s/he will have obtained one-fourth of the recommended MVPA. This is pertinent, as less than half of U.S. children are meeting this recommendation (Troiano et al., 2008).

Findings will provide insight into the best method to elicit TOT effects, which has the potential to inform potential mechanisms for the effect. That is, observation of a linear or curvilinear behavioral improvement between conditions (i.e., increase in TOT from control to inactive game, to low-moderate intensity game, to moderate-high intensity game) provides evidence for exercise-induced arousal as a mechanism. Alternatively, if TOT improvements observed following the inactive game are equal to those following the active games, attentional reset as a mechanism will be supported. This information can then be used to inform lesson structure to most effectively impact student engagement in the classroom.

## KEY TERMS

*Engagement:* students' action of attending to and participating in learning and academic activities (Fisher & Berliner, 1985).

*Time on-task (TOT):* the amount of time students spend attending to school-related tasks; a direct measure of student engagement (Prater, 1992).

*Physically active, academic lessons:* lessons of 15 minutes in duration, designed to integrate fact-based material with physical activity.

*MVPA*: moderate to vigorous-intensity physical activity, as indicated by accelerometer counts $\geq$ 1703 per minute.

*LMPA*: low to moderate-intensity physical activity, as indicated by accelerometer counts ranging from $\geq$ 100 to $<$ 4252 per minute.

*MET (Metabolic Equivalent):* the ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as 1 kcal/kg/hour and is roughly equivalent to the energy cost of sitting quietly. Also defined as oxygen uptake in ml/kg/min with one MET equal to the oxygen cost of sitting quietly, equivalent to 3.5 ml/kg/min (Ainsworth et al., 2011).

*Activity Counts:* a quantification of accelerations in the vertical and horizontal planes (in the present study; dual-axis), as measured by an accelerometer.

*Accelerometry:* the objective measurement of physical activity through usage of accelerometers.

*Accelerometers:* small devices designed to measure acceleration signals, which are processed and converted into meaningful classifications of physical activity outputs.

*Situational interest*: student affective reaction to participation in classroom lessons; reflective of active engagement in academic tasks (Schraw & Liehman, 2001).

*BMI: "*Body Mass Index." An indirect measure of adiposity based on height and weight measurements and typically used to screen individuals for weight categories that correspond to health problems (CDC, 2010).

*Physical activity:* any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen, Powell & Christenson, 1985).

*Exercise:* a subset of physical activity that is purposive, planned, structured, and repetitive with the goal of increasing fitness-related outcomes (Caspersen, Powell & Christenson, 1985).

*Fitness:* a set of attributes that are comprised of the components of cardiorespiratory endurance, muscular endurance, muscular strength, body composition, and flexibility (Caspersen, Powell & Christenson, 1985).

**CHAPTER 2**
**LITERATURE REVIEW**

Physical activity is an important aspect of children's health and development. Although children are recommended to obtain at least 60 minutes of moderate-to-vigorous intensity physical activity each day (CDC, 2010), it is estimated that fewer than half of U.S. children are meeting these recommendations. Concurrently, negative health outcomes historically occurring only in the adult population have been diagnosed in children, including type 2 diabetes, elevated blood pressure and low HDL cholesterol. Estimates show as high as 5% of children may have metabolic syndrome (Dubose et al., 2006). Additionally, physical activity declines drastically from childhood to adolescence, with 42% of children (aged 6 to 11 years) obtaining recommended levels to a mere 8% of adolescents obtaining this amount (Troiano et al., 2008), and only 18.6% of overweight and 15.4% of obese children, meeting the recommendations (Sun, Gao, Ransdell & Johnson, 2010).

In addition to failing to meet the MVPA recommendations, children are spending an increased portion of their day in sedentary time (Sturm, 2005). A growing body of research is examining physical inactivity as a distinct construct from physical activity. Time spent in physical inactivity has been associated with biomarkers of metabolic dysfunction in adults (Owen, 2009) and evidence supports the breaking up long periods of inactivity in terms of deriving health benefit (Strath et al., 2009). Children spend a large portion of their time in inactivity, as each school day lasts from 6 to 8 hours and the majority of this time is spent sitting (Sturm, 2005). Accumulating daily physical activity in intervals may both provide greater practicality than longer bouts and serve to disrupt extended periods of sedentary time.

Schools provide an ideal location to access children, as the majority of U.S. children attend school and they spend upwards of 30 hours per week at these institutions. Interventions have been done to increase physical activity in schools. One strategy is to increase the amount of time children are actively engaged in physical activity during periods of time already allocated to physical activity. Traditionally, these have been conducted during P.E. class or recess time, as the structure is already established to support activity and requires few additional resources from teachers. These interventions have had mixed results in improving physical activity engagement among children.

As the first large-scale, multi-site P.E. intervention the Child and Adolescent Trial for Cardiovascular Health (CATCH) program was designed to improve the quality of P.E. class through training teachers and modification of P.E. infrastructure. An ongoing trial, CATCH has been shown to be effective in increasing MVPA and VPA among students. This was achieved through increasing duration of P.E. class as well as time specifically allocated to fitness training (McKenzie et al., 2001). A similar program, project SPARK, has shown effectiveness in increasing physical activity among elementary children, resulting in a 50% greater time spent in MVPA and over 50% greater energy expenditure over the students not receiving the SPARK intervention (Sallis et al., 1997). Less consistent results have been found with self-report data. McKelvie (2002) implemented 10-12 minutes of anaerobic activity in a sample of preadolescent children (n = 278) during P.E. class two times per week over a 7-month period and found no change in self-reported physical activity levels from pre- to posttest between the intervention and control group. This study was replicated (McKelvie, 2004), increasing the intervention duration to 20 months and similarly found no change in self-reported physical activity levels. Use of physical activity self-report measures are known to have low validity in children, and may have been insensitive to the activity changes provided by this intervention. However, a subsequent P.E. based intervention of 10-15 minutes of jumping exercises at the beginning of P.E. class over 8 months in a sample of 9th grade children (n= 81) showed an interaction for gender. Specifically, self-reported physical activity decreased from pre- to posttest in the intervention condition among all students and among boys in the control condition. Again, it is unclear as to whether the self-report questionnaire was sensitive to the physical activity used in this intervention.

Recess-based interventions are similarly successful. A study designed to modify the recess environment included installing play areas at schools to increase participation in sports (e.g., added soccer goals, basketball hoops) as well as colorful open areas designed to encourage free play. Intervention schools were also provided with play equipment (e.g., balls, racquets, jump ropes) for children's usage during recess. When compared to control, the intervention was sufficient to increase time spent in MVPA, although not to a point of statistical significance (Ridgers, et al., 2010). Another recess intervention modified the recess environment by adding additional equipment and training P.E. teachers to encourage different types of activity participation. This showed time spent in MVPA at recess to significantly increase by 4.7 minutes for children participating in the recess the intervention condition (Huberty et al., 2011).

There are also non-equipment interventions for recess with less success. Jarrett (1998) implemented 10-15 minutes of structured physical activity into recess time in 4th grade children (n=43). No difference was found in directly observed activity levels at the posttest. In a similar study, Mitchell (2010) evaluated a 10-15 minute recess break of stretching and aerobic exercise over 5 months in 1,914 preadolescent children and found no observed (using SOFIT observation system) increases in pre-, post-physical activity.

A more effective means of targeting children may be during academic class time. As this is often the longest period children spend in sedentary time and targeting this time might provide stronger effects than targeting a time of normal physical activity, i.e. recess or P.E. In addition, targeting the regular education classroom would not only serve to increase physical activity, but also decrease the period of physical inactivity. Finally, this strategy would not require an increase in equipment and might require less extensive training. However, to justify usage of academic time, a demonstrable academic benefit to students is needed, as teachers often view physical activity interventions as a competing demand of classroom time (Ward et al., 2006). Accordingly, physically active, academic lessons were designed as a way to do this. These are designed to inject 10-15 minutes of MVPA incorporating academic content into the regular school day and have been shown to be effective in increasing physical activity levels among children, and include programs such as “Take 10!” (Kibbe et al., 2010), “Physical Activity Across the Curriculum” (Donnelly & Lambourne, 2011), and “Energizers” (Mahar et al., 2006). Furthermore, it is reasonable to believe that benefits would accrue with physical fitness level. To understand the potential academic effects of these, it is essential to understand the interaction of physical activity and cognitive function.

**Physical Activity and Cognitive Outcomes**

Original work on physical activity and cognitive function began with Spirduso’s (1975) studies on in the old adult population (aged over 60 years) that found improved reaction times in adults that participated in vigorous physical activity at least three times per week for three years, as compared with sedentary individuals; and reaction times equal to those of young exercisers (aged 20 years). This work gave rise to further exploration into the complex nature of physical activity and cognitive outcomes.

The first studies in children's physical activity and cognitive performance were Gabbard and Barton's (1979) experiment which tested mathematical computation prior to and following 20, 30, 40, and 50 minutes of vigorous physical activity. Scores were found to be significantly higher following the 50-minute condition. A further study by NcNaughten and Gabbard (1993) similarly evaluated mathematical computation speeds in a sample of sixth grade children (n = 120) after 20, 30 or 40 minutes of moderate intensity walking. Results indicated significantly higher scores on a 90-second math test following the 30 and 40-minute durations compared with the 20-minute duration of physical activity. Caterino and Polak (1999) examined concentration following an in-class physical activity of 15-minutes of vigorous intensity aerobic exercise as compared with 15-minutes of stretching. Fourth grade students showed significant improvements on tests of speeded stimulus identification, whereas null effects were observed for second and third grade children. Findings in this area of children's physical activity and cognitive outcomes were summarized in Sibley and Etnier's (2003) meta-analysis of 44 studies. Effect sizes (Hedge's g) showed greater effect for acute physical activity (ES = 0.37) compared to chronic training (ES = 0.29); and for resistance training (ES = 0.64) over aerobic activity (ES = 0.26). The effect of overall fitness assessed cross-sectional and correlational studies yielded an effect size of 0.34.

Further studies have shown that physical activity incorporating cognitive engagement may have a greater effect on subsequent cognitive performance than do those of physical activity alone. In Budde et al.'s (2008) study of adolescents (aged 13-16 years), students were measured on a test of concentration and attention (d-2 test) prior to and following a regular seated classroom lesson, a 10-minute bout of coordinative exercise (designed to elicit mental engagement) and a 10-minute exercise lesson. Results indicated improved performance in the two exercise groups, with the mentally engaging physical activity eliciting the greatest improvements on concentration and attention. In a study of fifty-two children (aged 11-12 years), Pesce et al. (2009) assessed memory performance on a test of free-recall following a 40-minute aerobic exercise activity, a 40-minute aerobic exercise activity designed to engage children in motoric problem-solving abilities, and an inactive control condition. Results indicated children's recall to be greatest following the cognitively engaging aerobic activity, followed by the traditional exercise activity and lowest following the no-exercise control condition. Thus, these data suggest that engaging, physically active lessons hold potential to benefit cognitive performance.

In the applied setting, a correlational study examined physical activity levels as measured by student report (3-day physical activity recall) and academic achievement through a composite score of grades across the core curriculum and standardized test scores. Results indicated that students meeting the recommended dosage of vigorous intensity daily physical activity had higher achievement scores than children not meeting the guidelines. No relationship, however, was observed for children meeting guidelines for moderate intensity levels of physical activity (Coe et al., 2006).

## Hypotheses of Cognitive Function

Cognitive functioning affected by physical activity may be categorized into four hypotheses: processing speed, visuospatial processing, controlled processing, and executive control. Processing speed is operationalized as low–level neurological functioning; visuospatial processing as a transformation or recall of visual or spatial information; controlled processes as use of cognitive control to complete a task; executive function as planning, inhibition, and scheduling of mental procedures (Colcombe & Kramer, 2003). Examples of tests used to measure these processes include reacting quickly to a stimulus or tapping one's finger as rapidly as possible for a 20 second period (processing speed); viewing three line drawings and later replicating them from memory or geometric shape rotation (visuospatial processing); reacting to one of two or more stimuli ("CRT," choice reaction time) (controlled processing); respond to a central cue but simultaneously suppress conflicting or irrelevant cues presented next to a target stimulus, e.g., "flanker" and "stroop" tasks (executive/cognitive control), (Spirduso, 2005).

The majority of work testing cognitive hypotheses and exercise have been conducted in the adult population, with more recent work examining these in children. Findings of exercise effects on processing speed have been equivocal. Studies reporting beneficial exercise effects found exercising participants to perform better on reaction time tests (Dustman et al., 1984; Rikli & Edwards, 1991). However, Barry et al. (1966) and Madden (1988) failed to find changes in reaction time accompanying improvements in aerobic capacity (Spirduso, 2005).

Visuospatial processing requires multiple resource allocation, and therefore demands a substantial amount of attentional focus to complete (Chodzko-Zajko & Moore, 1994). Tasks of this type require effortful processing, which is most likely to decrease as a function of aging (Spirduso, 2005). For this reason, tasks requiring effortful processing may be more affected by an exercise program (Chodzko-Zajko et al., 1992; Stones & Kozma, 1998). However, Kramer et al. (2006) contend that the exercise effects are resultant not of resource allocation, but of executive control.

Controlled processing was reported to improve following participation in a one-year exercise program and remain stable through two more years of the exercise program in a group of subjects aged 59 to 81 years, with the reaction times of the nonexercisers significantly lower after three years than pre-study (Rikli & Edwards, 1991). Dustman et al. (1984) failed to find an effect on controlled processing as a function of exercise.

Executive function, the processes involved in scheduling, planning, and inhibitory control, is believed to be the cognitive processes most impacted by exercise. Furthermore, executive control processes have been found to decline substantially as a function of aging (Kramer et al., 1994; West, 1996). Colcombe and Kramer's (2003) meta-analysis found executive function to be the cognitive process most affected by exercise, with a moderate to large effect size (Hedge's *g*) of .68. Individual studies examining this relationship include Kramer et al.'s (1999) exercise intervention examining tasks of executive control versus single operation tasks (e.g., visual search, spatial attention, tracking, working memory, perceptual comparison) in a population of older adults participating in either a six month walking program or a toning and stretching program. Significant improvements were found in the walking group for tasks requiring executive control. VO2 max tests showed that fitness effects elicited by the walking protocol were related to increases in executive control.

In specific application in children's physical activity, it is hypothesized that cognitive control is the facet most responsible for cognitive and academic performance following exercise (Hillman et al., 2006). Cognitive control encompasses processes of working memory, inhibition, cognitive flexibility as well as goal-directed, self-regulatory processes (Diamond, 2006). Direct effects on cognitive control have been tested in the laboratory setting. Children (mean age 9.5 years) tested following a 20 minute treadmill walk, at 60% estimated maximum heart rate, showed increased academic achievement scores in reading, spelling, and math, and improvements in cognitive control. Specifically, increased response accuracy and greater P3 amplitudes (indicative of greater allocation of attentional resources), were observed compared to an inactive control group (Hillman et al., 2009b). Fitness effects were reported, such that children of higher cardiovascular fitness levels displayed greater P3 amplitudes, faster reaction times, and greater inhibitory control than those children categorized as unfit (Buck, Hillman, & Castelli, 2005).

On the contrary, null findings exist for the physical activity-cognition relationship in children. A study in adolescents (Stroth, et al., 2009) found no effect of acute bouts of aerobic exercise on executive function. However, children with higher fitness levels, as measured by continuous graded maximal exercise test on a stationary bike, showed higher contingent negative variation (CNV), a reflection of enhanced task preparation processes, and decreased N2 amplitudes, suggesting increased efficiency in executive control. Acute exercise was not found to affect attentional measures. P3 amplitudes were not associated with fitness or acute exercise response (Stroth, et al., 2009). A study in overweight, sedentary children (mean age: 9.2 years) found no effect for a bout of treadmill walking on task-switching, a measure of executive function assessed by decrease in processing time required to switch performance between tasks (Tomporowski et al., 2008). These findings fail to support the positive effect of acute bouts of exercise on children's executive function. These disparate findings suggest the necessity for further investigation into this area.

**Academic Outcomes, BMI and Fitness**

Links have also been shown between BMI and cognitive test performance. Li et al. (2008) showed that high BMI was associated with decreases in visuospatial organization and general mental ability in a sample of children aged eight to 16 years (n=2,519). However, null findings were reported by Gunstadt et al. (2008) which found BMI to be unrelated to test performance on neuropsychological tests in children aged six to 19 years (n=478). However, the bulk of the work is more supportive. Significant differences have been observed between overweight/obese and normal status on GPA, reading scores, and math scores (Shore et al., 2008; Datar et al., 2009). BMI has been found to have a negative association with academic achievement (Castelli, Hillman, Buck & Erwin, 2007). In fact, shifting to obese status between kindergarten and third grade is a significant risk factor for declines in academic achievement (Datar & Sturm, 2006). Thus, in total, it seems that BMI is an important potential moderator of academic outcomes.

Children's aerobic fitness has been found to be positively correlated with academic achievement (measured via ISAT; Illinois Standardized Test) in the areas of math, reading, and overall achievement (Castelli, Hillman, Buck, & Erwin, 2007). Academic performance assessed in a sample of $5^{th}$ grade students found that children that passed the aerobic capacity test of FITNESSGRAM, (i.e., in the "Healthy Fitness Zone") scored significantly higher on achievement tests. An obvious concern is that fitness varies with BMI, gender and SES. However, the relationship with fitness did not vary according to BMI, gender or SES (Wittberg, Northup & Cottrel, 2009). Further, passing scores on state academic achievement tests were correlated with the number of fitness tests passed in P.E. class, when BMI, ethnicity, gender, and SES were held constant (Chomitz, 2009).

Physically active lessons were associated with improved academic achievement in the context of three-year longitudinal, randomized, controlled trial. These lessons were designed to deliver 90 minutes of MVPA per week, through 10-minute lessons implemented at the teachers' discretion. Children in the intervention exhibited 27% greater levels of MVPA ($\geq$ 4 METS) over those in the control schools. Significant improvements were found in the areas of math, reading and spelling from baseline to 3 years in the intervention group compared with the control (Donnelly et al., 2009).

Academic achievement in math was associated with participation in a 2-year physical and nutrition physical activity intervention in low-income ethnic minority children, compared to a no intervention control school (Hollar et al., 2010). However, physical activity was not specifically prescribed, nor measured; teachers were simply "asked to implement 10-15 minute physical activity lessons," and the physical activity component was implemented in year 2 of the program, only. Across the aforementioned study, lessons were implemented over a range of intensities with some variation in implementation.

**Application of Cognition in the Classroom: Academic Learning Time (ALT)**

One of the aspects of cognitive function that has received the least attention is Academic Learning Time. The ways in which children spend time in the classroom is highly pertinent for educators and those involved with children's academics. It has been estimated that in some instances, less than half of a child's school day is devoted to instruction, with academic engagement rates ranging from as little as 50% to an upper limit of 90% (Hollowood, Salisbury, Rainforth & Palombaro, 1995).

Original work in this area began with Carroll's (1963) model of school learning, which hypothesized that learning is a function of time engaged relative to time needed for learning. The most comprehensive examination into the relationship of learning time and academic performance was the Beginning Teacher Evaluation Study (BTES), (Denham & Lieberman, 1980) which aimed to isolate conditions related to teaching and the classroom that facilitated student learning. Following this six-year study, the concept of Academic Learning Time (ALT) was developed to refer to the amount of time in which students are actively and productively engaged in learning; and was found to be a strong predictor of academic achievement (Fisher & Berliner, 1985).

ALT is conceptualized as a function of three components. These are: allocated time, which refers to the amount of time that teachers allocate for instructional activities; instructional time, defined as the proportion of allocated time that is actually used for instruction; and engagement time, which is the proportion of time that students are actively engaged in learning. Although each of these components are positively correlated with student learning, engagement time is the strongest predictor of academic achievement (Gettinger & Stoiber, 1999).

In order for educators to maximize academic performance, assessments of classroom time usage are necessary to provide a clear picture of ALT in the classroom. The three primary assessment techniques used to this end are: self-analysis of time use (in which teachers analyze their own use of instructional time to identify areas of improvement), ecobehavioral assessment by external consultants (researchers use measurement tools to quantify ALT); and functional assessment through collaboration between teachers and consultants (an observational and iterative process between these parties to identify improvement strategies). Of these, ecobehavioral assessments provide the most targeted approach to measuring student engagement (Greenwood, Carta, & Atwater, 1991).

Ecobehavioral assessments designed to measure student engagement are often quantified as time on-task. Time on-task (TOT) refers to the amount of time students spend attending to school-related tasks (Prater, 1992) and is a direct measure of student engagement. Similar to student engagement, TOT is positively associated with academic performance (Stallings, 1980) and an effective means of quantifying academic learning time.

***Physically Active Lessons and TOT***

Due to the classroom context, the effects of physically active academic lessons on academic learning time has been of particular interest. This work has specifically examined TOT as a function of physically active classroom lessons. Mahar et al. (2006) tested the effects of active lessons on subsequent on-task behavior in a sample of third and fourth grade children. TOT was measured prior to and following a physically active lesson and a control lesson. Results indicated that time on-task increased by 8% in the period immediately after completing the physically active lesson. While this study provided support for the ability of active lessons to impact TOT, it did not, however, examine this as a function of weight status.

A follow-up study showed an effect for BMI on TOT (Grieco, Jowers & Bartholomew, 2009). This study was designed to examine the effects of a physically active classroom lesson on on-task behavior and the role of BMI in this effect. Results were similar to those of Mahar et al. (2006) showing an increase in TOT following the active lesson and a decrease in TOT following the inactive lesson.

Specifically, TOT decreased significantly from pre- to post-lesson for all BMI categories in the inactive control lesson condition, with the reduction in TOT increasing with each level of BMI. This trend was illustrated by the magnitude of the change in TOT by BMI category: normal weight ($d$ = -0.39), at-risk ($d$ = -0.68), and overweight ($d$ = -1.28), indicating that higher BMI category was inversely related to TOT following an inactive lesson. In the active condition, TOT increased slightly following the active lesson (normal weight ($d$ = 0.13), at-risk ($d$ = 0.26), and overweight ($d$ = 0.26)), although the difference was non-significant, and BMI did not interact with TOT following the active lesson. These data are presented in table 1.

**Table 1**. Means and standard deviations for percentage of TOT of students (N = 97)

| | ***Pre-lesson*** | ***Post-lesson*** | ***Effect Size (d)*** |
|---|---|---|---|
| Active lesson | | | |
| Normal weight | 85.5 (±19.4) | 87.8 (±16.2) | 0.13 |
| At-risk | 86.1 (±14.5) | 89.6 (±12.2) | 0.26 |
| Overweight | 90.8 (±10.6) | 93.3 (±8.7) | 0.26 |
| Control lesson | | | |
| Normal weight | 81.8 (±16.2) | 74.4 (±22.1)* | -0.39 |
| At-risk | 85.8 (±17.9) | 72.2 (±22.1)* | -0.68 |
| Overweight | 84.4 (±16.2) | 57.9 (±25.3)***† | -1.28 |

** Indicates a significant pre-, post-difference, $P < .05$*
**** Indicates a significant pre-, post-difference, $P < .001$*
*† Indicates significant difference from normal weight group, $P < .05$*

Furthermore, a linear effect was observed for physical activity level, such that children categorized as overweight and at-risk, took fewer steps than those children in the normal weight category (table 2). Step counts were assessed during similar lessons with overweight children taking significantly fewer steps than their normal weight counterparts. The pronounced effect of physical activity on TOT behavior for the overweight children ($d$ = -1.28) as compared to the normal weight children ($d$ = -0.39) may be resultant of the lower overall activity levels of overweight children over the course of the day. Because overweight children have lower levels of movement overall, this concentrated dose of physical activity may provide a more potent effect for these children. This provides support for examining the dose-response of varying physical activity intensities, with regard to the moderating effects of BMI status and fitness level.

**Table 2**. Means and standard deviations for step count and BMI.

| | *Steps·day$^{-2}$* | *BMI (k·m$^{-2}$)* |
|---|---|---|
| Normal weight (N=62) | 5654 (±2106) | 16.1 (±1.1) |
| At-risk (N=17) | 4829 (±1731) | 19.1 (±1.3) |
| Overweight (N=16) | 4405 (±1716)* | 25.2 (±3.5) |

*Significantly different from the on-weight group, $P < .05$

**Dose-Response of Physical Activity Intensity on Cognitive Function**

The majority of studies examining physical activity on cognitive and academic-related outcomes in children have utilized aerobic physical activity at a moderate-intensity as the experimental manipulation. It is generally thought that cognitive functioning improves following moderate-intensity physical activity up to a point (e.g., Kashihara et al., 2009), then attenuates and declines following high-intensity physical activity (e.g., Chmura et al., 1994). Furthermore, this relationship is dependent upon the difficulty and complexity of the cognitive task. That is, cognitive functioning on complex tasks (e.g., those involving inhibitory control) varies as a quadratic function of physical activity intensity, in an "inverted U relationship" (Arent & Landers, 2003; Chang & Etnier, 2009), whereas performance on simple tasks (e.g., response time) relate linearly to intensity (Davranche & Audiffren, 2004; McMorris et al., 2005). Thus, the optimal intensity for cognitive function is hypothesized to be approaching, but not exceeding, lactate threshold (Kashihara et al., 2009).

Two studies to date have specifically examined the dose-response of intensity on cognitive function. Chang and Etnier (2009) utilized a protocol requiring participants to perform a 30-minute bout of resistance exercise at 40%, 70% or 100% of their 10-

repetition maximum and then assessed cognitive performance. Results indicated a dose-response of exercise intensity on cognitive performance, such that moderate-intensity exercise was most beneficial for executive function and high-intensity exercise was most beneficial for cognitive processing speed. However, this protocol was limited to resistance exercise in the adult population. Thus, application and generalizability to children in the classroom setting may be limited.

A study of overweight children examined the dose-response of exercise volume on cognitive functioning. In the context of a 15-week intervention, overweight children classified as inactive were randomized into a control, low exercise dose (20 min/day, five days/week) and high exercise dose (40 min/day, administered as two sessions of 20 min., five days/week). The intensity was similar between conditions (average heart rate = 166 bpm). Results indicated a significant improvement in cognitive functioning between the control and high exercise dose groups only, thus supporting a threshold, but not dose-response relationship of exercise volume on cognitive function. This sample was limited to overweight, inactive children of whom may be more responsive to exercise. Cognitive responses may vary by weight status and physical activity level. As such, the need exists for testing cognitive responses across varying levels of weight status and physical activity level, and extending this work into the applied setting of schools, to determine the impact on academic and behavioral outcomes.

**Exploratory Mechanisms**

Multiple mechanisms provide tenable explanation for the TOT effects observed following physically active academic lessons. These mechanisms include arousal, physiological facilitation of cognition, self-regulation and attentional reset. Specifically, TOT improvements may be due to physical activity-induced arousal impacting cognitive control. If arousal or physiological mechanisms affecting cognitive function are underlie this relationship, post-physical activity cognitive functioning may be responsible for increasing allocation of mental resources and cognitive control to the task at hand. If this is the case, then TOT would be expected to improve in the physically active game conditions only, with a greater magnitude of effect possible for the moderate to high-intensity condition over the low to moderate-intensity condition.

However, TOT improvements may instead be due to a break in typical classroom routine. If this is the case, then theories of attentional reset and self-regulation are supported. That is, diminished attentional or self-regulatory resources are replenished by means of the break in what can be a tedious sedentary lesson, thereby allowing children to refocus attention and better regulate behavior. If the underlying mechanism is attentional reset or self-regulation, then on-task behavior in the current study would be expected to similarly improve following the physically active game conditions and the inactive game (with no behavioral improvement following the inactive (traditional lesson) control).

***Arousal***

The mechanism of behavioral improvement following physically active games may instead follow a change in arousal peculiar to physical activity. There appears to be a relationship between central nervous system (CNS) activation and exercise intensity. As exercise intensity increases, so, too, does CNS activation, which may facilitate cognitive functioning. Indeed, cognitive performance following exercise improved a mean effect of 0.20, across 29 studies (Lambourne & Tomporowski, 2010). The optimal intensity of exercise in facilitating cognitive functioning may be close to lactate threshold (LT) (Chmura et al., 1994), although intensities exceeding LT appear to result in cognitive impairments, in concert with the “inverted U-hypothesis” (Duffy, 1972). Thus, moderate intensity exercise may provide the ideal level to facilitate cognitive function following exercise, but not to the point that stress hormones (e.g., cortisol) are released thereby impairing performance (Kashihara et al., 2009).

***Physiological Mechanisms***

Multiple physiological mechanisms support facilitation of cognitive performance through physical activity. Adaptations associated with physical activity training include improvements in cerebrovascular integrity through development of capillaries (angiogenesis), increases in oxygen transport and reduction in brain hypoxia, enhanced blood flow to active regions of the brain (increases in cerebral blood flow) (Tanaka, 2009). These may lead to an increase in glucose utilization in the brain areas associated with memory storage and retrieval (Manning et al., 1998). Furthermore, physical activity may aid in recruitment of brain regions specific to the tasks (Kramer & Hillman, 2006) and has been shown to increase brain plasticity, through increasing production of brain-derived neurotrophin factor (BDNF) (Spirduso, 1980) and insulin-like growth factor-1 (IGF-1), which have been shown to stimulate neurogenesis and increase resistance to brain insult (Cotman & Berchtold, 2002). These effects may be responsible for improvements in learning and mental performance. Additionally, because of the developmental status of their central nervous systems, children may derive a greater benefit from physical activity than do adults, whose brains are in a state of dedifferentiation (Cabeza, 2001).

### *Attentional Reset*

Theories of attentional reset assert that through some sort of energy release or break from activity, attentional resources are replenished, thereby allowing for an extension or improvement of attentional focus. In the school context, in which children are required to sit and work for the majority of the school day, it may be that an energy surplus is generated and must be expended in order for children to maintain engagement throughout the day. Thus, breaks incorporating physical activity (e.g., recess) are a necessary means to expend this extra energy (Pellegrini & Smith, 1993). Indeed, this claim is reflected through educator beliefs that it is only following dispensation of the surplus energy (via breaks), that children are able to return to their work with sufficient resources to engage in required tasks (King, 1987). However, this theory may be limited by its ability to quantify energy surplus; and in explaining why children continue to engage in physical activity past exhaustion of this surplus energy (Evans & Pellegrini, 1997).

Alternate explanations for improved classroom engagement following a break exist. Novelty theory suggests that children become less attentive as a function of time spent sitting and working in class due to diminished interest in the task at hand. Thus, a break provides children with an attentional shift sufficient to make the subsequent task (return to class work) novel, once again (Ellis, 1984). Cognitive Immaturity Hypothesis (Bjorklund & Pellegrini, 2000) provides a developmental view, suggesting that the cognitive interference experienced among children while learning challenging material results in subsequent performance decrements. These decrements may be lessened through usage of breaks in learning-time. It is further suggested that unstructured breaks are needed to elicit this effect in younger children, whereas for older children, task-switching is sufficient.

***Self-regulation***

A variant of attentional reset is based on models of self-regulation. Rather than an energy surplus to be released, it posits a reservoir of control that must be replenished. Theories of self-regulation provide a tenable explanation for the behavioral improvement following physically active lessons in the school setting. Although used interchangeably in certain contexts, this review will use the terms, “self-regulation” to refer to the broad and global effort to maintain alignment between goals and behavior, and “self-control” as the specific process by which self-regulation is realized, that is, the exertion of control over a certain behavior. The Muraven and Baumeister (2000) model of behavior posits self-control as a finite resource, where every exertion of self-control over behavior diminishes self-regulatory strength. This may be conceptualized in terms of a reservoir of self-regulatory strength that decreases in volume with each event requiring restraint. Over time, the reservoir becomes exhausted, which, in turn, decreases strength and ability to maintain subsequent control. It may well be that the break in routine provided by physically active lessons is responsible for the increase in behavioral control. That is, the demands of the school day require students to continually exert control over their thoughts and behavior. As a result, self-regulatory strength is depleted, which is particularly true for periods of sedentary activity. Physical activity may provide enough of a break in routine to allow a child sufficient time to replenish self-control over behavior during subsequent academic time. This will not distinguish these possibilities, but the general concept will be tested via the inactive academic game (game control).

Although arousal was not measured in this study, this design provides an initial test of time on-task (TOT) following an acute bout of physical activity.  As, such the present study tested the effects of physically active lessons of varying intensity on TOT. Specifically, if the underlying mechanism is attentional reset, then the level or presence of PA is not required.  If, instead, arousal facilitates cognitive and attentional improvements, then differences are expected to exist between the LMPA versus MVPA conditions as well as the inactive conditions and provides justification for the dose-response of physical activity on TOT.

In sum, this study was designed to test differing lesson types on children's TOT during academic learning time.  Specifically, conditions presented were: (1) low to moderate-intensity physically active lesson, (2) moderate-to-high-intensity physically active lesson, (3) inactive game (interest control), and (4) traditional inactive lesson (physical activity control).  Findings (to follow) provided support for the benefits of physically active lessons and, to a lesser degree, an inactive break in increasing children's on-task behavior in the classroom.

# CHAPTER 3
# METHODS

## Design Overview

A two (time: pre-, post-lesson) x four [lesson condition: (1) low to moderate-intensity physically active lesson, (2) moderate-to-high-intensity physically active lesson, (3) inactive game (interest control), and (4) traditional inactive lesson (physical activity control)] mixed within (pre-post) / between (condition) subjects design was used to assess percentage of time spent on-task (TOT). TOT was measured during 15-minute classroom observations both prior to and following each of the four lesson conditions. Because activity in physical education (P.E.) might impact TOT, all observations were conducted on non-P.E. days, with condition randomly assigned by classroom.

Earlier research has relied on teachers to implement these lessons - this is, in fact, the rational that underlies physically active lessons. Unfortunately, teacher implementation raises the possibility of errors in implementation – particularly with regard to the intensity manipulation. In response, and to ensure fidelity to treatment, the lead researcher implemented all conditions with each class. Although this lowers the generalizability of the manipulation, this approach was considered of secondary importance to the need to ensure accurate implementation of the procedures. This is especially true as the generalizability of teacher-implemented lessons has been repeatedly demonstrated (Donnelly et al., 2009; Grieco, Jowers, & Bartholomew, 2009; Mahar et al., 2006). Finally, to ensure that the experimenter implementation did not impact TOT ratings, a separate group of trained researchers conducted all TOT assessments.

## Participants

Participants were 3rd, 4th and 5th grade students (ages 7-12 years) recruited from elementary schools in central Texas. This age-range reflects the participant demographic in studies designed to examine similar outcomes (Mahar et al., 2006; Donnelly et al., 2009) and represents the age group in which physical activity declines significantly (Sun, Gao, Ransdell & Johnson, 2010; Trost et al., 2002). No gender or ethnic/racial preference was made for participation.

*Consent Procedures, Recruitment and Incentives*

District approval and a support letter from the school principal (Appendix A) were obtained from the Round Rock Independent School District (RRISD). All participants were provided with informed consent (Appendix B) prior to participation. Teachers sent parental informed consent home in student homework/notification folders. Consent forms included a brief description of the project and contact numbers for further information and have been approved by The University of Texas Institutional Review Board (see Appendix C for IRB forms). Students returned consent forms to their teachers. Students with parental consent to participate in the study were given assent forms (Appendix D) by project staff and asked to sign in their presence. Students were given a pencil for returning consent forms, regardless of consent status. Teachers received a $15 gift card for their participation in the study. All consent and assent forms were stored in a locked, controlled access file cabinet in the Exercise and Sport Psychology Laboratory at UT Austin.

**Lesson Background**

The physically active academic lessons used in this study were developed based on the “Texas I-CAN” program, a large study designed to increase physical activity among children and achieve academic curricular goals through movement in the regular education classroom (as opposed to the physical education class). The lessons required 10-15 minutes of moderate-to-vigorous intensity physical activity (MVPA) and are similar to other active lessons implemented in the classroom (Stewart, Dennison, Kohl & Doyle, 2004; Gibson et al., 2008; Mahar et al., 2006). Lessons cover math, language arts, science, social studies, and health along with general lessons accommodating to any fact-based content.

**Treatment Basis**

Following a review of pilot work, “Spelling Relay” (see Appendix E for a model of how the lesson is presented to teachers) was found to be the most applicable lesson across grades and therefore selected as the treatment lesson. This lesson consists of dividing students into separate groups. Staff gave the students a spelling word based on the word list under study during that week. Upon a starting cue, the first child in each group would write a letter, followed by the second child, and so forth. Each participant would, in turn, either add a letter or correct an error. This would be repeated until one group completed the word correctly. The process would begin again with a new word from the list until the 15-minute lesson expired. This lesson was the treatment upon which each condition was modified (described to follow), in order to provide a test of the research questions.

**Description of Lesson Conditions**

*Moderate-Vigorous Physical Activity (MVPA) Game*

In the MVPA condition, students were divided into a six lines, with approximately 3 students per group. Students were instructed to run to and from the board. Further, students were instructed to stand and execute various jumps (e.g., star jumps) as they awaited their next turn. (A full description of the lesson, including additional physical activities is included in Appendix E).

*Low-Moderate Intensity Physical Activity (LMPA) Game*

In the LMPA condition, students were divided into four groups, with approximately 5 students/group. This was done to reduce the number of turns for each child. Students were instructed to walk to and from the board, adding a letter in chalk at each turn. Once finished students were instructed to sit down between turns. (See Appendix F for full lesson description.)

*Control Game*

For the inactive control the students were seated in a group of four tables. These four table groupings were selected as they are the dominant structure to the classrooms at the participating elementary school. Students worked on a piece of paper that was passed around the circle of four desks, with each subsequent student adding a letter. When complete, all students laid their writing implement on the table to signal completion. (See Appendix G for lesson description for teachers.)

*Control Lesson*

For the traditional inactive lesson condition, project staff read a spelling word aloud. Students were seated at their desks in silence and were instructed to write the word in “pyramid style.” This a commonly used activity in the classroom, where students begin with the first letter of the word on one line, then two letters on the second line, and so forth until the full word is completed. The order is then reversed, removing a letter at each line (See Appendix H for example.) The next spelling word was then read and the process repeated for the duration of the 15-minute lesson.

**Procedure**

**Accelerometer Distribution and Classroom Preparation**

Upon entry into the classroom, and permission from the teacher, project staff filled out classroom checklist sheets (see Appendix I for an example of completed sheets). Students were called over to the equipment distribution area (table at periphery of classroom) and outfitted with an accelerometer (affixed upon right hip (superior iliac crest)) and an observation number printed on a 4” x 6” piece of paper (affixed to back). Accelerometer numbers and observation numbers were verified in accordance with students’ names. Following receipt of equipment, students were sent back to their desks to continue working on the assigned lesson. Observers then prepared for the observations by deciding which students each was to observe and sketching out the seating configuration on the observation sheets. (See Appendix J for a blank observation sheet and Appendix K for an example of a completed observation sheet).

**Time On-task (TOT) Observations**

Time on-task (TOT) was measured though Momentary Time Sampling (MTS), a type of ecobehavioral assessment. This form of assessment is based on direct observation of student engagement in academic tasks. It has a long history of use for assessing engagement and attention control (Haynes & Kerns, 1979) and has most often been used for the assessment of evaluations of interventions (Hodge, 1985). Decisions regarding the length of each observation within a visual "sweep" of the class were based on variations in the behavior under study and the number of children to observe. Generally, this falls within 1 to 30 second observations for each child (Harrop & Daniels, 1986). Although it may be expected that longer observations increase accuracy, longer observations can result in missing the behavior in other children within the sweep. In fact, observations of more than 5 seconds were found to be less reliable (Gardenier, MacDonald & Green, 2004). Accordingly, the present observation period was set at 5 seconds per child.

This observational procedure was implemented by two members of the research team. In order to maximize observations for each student, students were divided into two separate regions of the classroom and each observer coded behavior for his/her region of the class. Depending on class size, each observer coded behavior for eight to 11 students. During each 15-minute observation period, the observer rotated through his/her assigned region, observing each student for a 5-second period. Each observer listened to an MP3 file via an earpiece that signaled every fifth second. At the signal, the observer noted the appropriate behavior code and began observation of the next student. On-task behavior was defined as any behavior in which a student is attentive to the teacher or actively engaged in the appropriate task, as assigned by the teacher. Off-task behavior was defined as actions whereby a student was disengaged or distracted from the assigned task (i.e., behavior outside of the specifications of "on-task" behavior). Examples of off-task behavior included a student: gazing off, placing head on the desk, reading or writing inappropriate or unassigned material, talking to or looking at other students when not part of a given assignment, and leaving the desk without receiving permission from the teacher. This process of observing and recording behavior was repeated for the duration of the observation period and resulted in a total of 16 – 22 observations for each student, depending on class size. TOT was calculated for each student by dividing the number of on-task observations by the total number of observations per student.

Observations were conducted during the language arts period, which is the longest sedentary period, on non-P.E. days. Language arts lesson structure was consistent across each grade. Students were observed for a period of 15-minutes prior to ("pre-lesson") and again for a period of 15-minutes following ("post-lesson") the (1) LMPA game (2) MVPA game (3) control game or (4) control lesson, depending upon condition assignment. Lesson condition was randomly assigned across classrooms.

***Observer Training and Reliability***

Observers were trained in a separate set of elementary classrooms to prevent contamination of the observations. Training centered on viewing, coding, and recording behavior over two weeks prior to commencement of the study, with multiple iterations of observations and discussions involving the research team and classroom teachers. Training was considered complete when inter-rater reliability (IRR) (as a mean percentage of agreement of on-task and off-task behavior scores among all observers participating in the study) exceeded 90%. IRR was calculated at 92% at a pretest assessment (one-week prior to the experiment) and 95% at a one-week retest. These values are in line with previous studies that yielded IRR at 90% at pretest and 94% at a three-month follow-up assessment (Grieco, Bartholomew & Jowers, 2009).

**Survey Administration, Equipment Collection and In-class Data Recording**

Following the second TOT observation, project staff distributed situational interest surveys (Appendix L) to each participating student. Instructions were read aloud along with the question and answer choices. Students were given time to complete surveys after which were collected by project staff. Students were then called over to the equipment distribution area and the post-observation sheet (Appendix M) was completed to ensure collection of accelerometers and verification of accelerometer and observation numbers. TOT observations data were totaled for each student and recorded on the observation sheet, along with students' responses to the situational interest survey.

**Physical Activity**

There are numerous methods to objectively collect physical activity data in children. These include: direct observation, pedometry, and accelerometry. Observations of physical activity are similar to our assessment of TOT and involve trained observer rating the intensity of activity of children (McKenzie, 2005). Although this approach is useful for collecting contextual variables (e.g. how activity differs as a function of playground or PE environment) they are less useful for determining an absolute level of physical activity in a given period. Pedometers have been used with great success in school-based studies, with clear norms established for number of steps taken in different settings (Tudor-Locke, et al., 2009). Unfortunately, pedometers do not allow for a precise assessment of activity intensity and are, as a result, poorly suited for the kind of dose repose assessment needed for the present experiment. In contrast, accelerometers are widely considered the most accurate means of capturing physical activity of different intensities (Welk, Schaben, & Morrow, 2004; Tudor-Locke, Johnson, & Katzmarzyk, 2010).

Accelerometer data were collected using Actigraph GT1M accelerometers (Fort Walton Beach, Florida). These devices are designed to collect data through sampling accelerations in the vertical and horizontal planes. The sampling interval (epoch) was set at 5-seconds, to best capture the variability in children's activity (McClain et al., 2008). Given the short bouts of activity in the study protocol (e.g., 4 quick jumping jacks, approximately 3 seconds in duration), it was decided that the 5 second epoch would best capture differing activities, as opposed to a longer epoch; and no shorter due to data handling purposes. Although placement has not been supported as a key issue in interpreting accelerometer data (Nilson, et al., 2001), hip placement has been successfully used with children (Treuth, et al., 2003; Trost, et al., 2002). Accelerometers were, Although placement has not been supported as a key issue in interpreting accelerometer data (Nilson, et al., 2001), hip placement has been successfully used with children (Treuth, et al., 2003; Trost, et al., 2002). Accelerometers were, therefore affixed to a belt, worn over the right hip by trained program staff and removed following cessation of behavioral observations. At this time, accelerometers were collected and data downloaded. Accelerometer data were processed using ActiLife v5.5 software. Data were collected in 5s epochs and reintegrated to 60s epochs for MET rate calculation. Average activity counts were calculated using summed counts during each lesson. Time spent per lesson at various intensity levels were calculated using child-specific cut-points (Freedson, 2005). These cutpoints were used due to their validity in children ages 8.2-15 (Freedson, 2005), as well as their superior reliability (κ= 0.66) over other proposed cutpoints (Puyau, Treuth, and Mattocks) in this age group in estimating activity intensity across sedentary (e.g., sitting, writing), lifestyle (e.g., aerobics, basketball), and ambulatory (e.g., walking, running) activities, which are similar to those in the current study protocol (Trost et al., 2010).

**Body Mass Index (BMI)**

BMI was assessed for all participants. Heights and weights were released from the district P.E. teacher, for those children with parental consent and assent. BMI was then calculated [weight (kg)/ (height (m))$^2$]. The FITNESSGRAM, which is used in this experiment to indicate fitness category, also provides a categorization of BMI levels. However, the majority of the extant literature utilizes the CDC categories for BMI. As a result, participants were assigned to the appropriate weight category for age and sex in accordance with CDC "BMI-for-age" growth charts: underweight: < 5$^{th}$ percentile; normal weight: 5$^{th}$ ≤ 85$^{th}$ percentile; at risk for overweight 85$^{th}$ ≤ 95$^{th}$ percentile; and overweight: ≥ 95$^{th}$ percentile (CDC, 2008).

**Physical Fitness**

Physical fitness is defined as "the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (Caspersen, Powell & Christenson, 1985). As such, it includes components of aerobic capacity, muscular strength and endurance, flexibility, and body composition. The FITNESSGRAM (Lacy & Marshall, 1984; Meredith & Welk, 2007) is mandated in Texas elementary schools to assess physical fitness in elementary school students. It uses measures of aerobic capacity (PACER run), muscular fitness (curl-ups, trunk extension, push-ups), flexibility, and BMI to categorize children by into varying levels of fitness. Despite the variety of indicators, the extant literature on cognitive function has largely limited itself to the use of the PACER portion of the test of similar scores for aerobic capacity as the primary indicator of physical fitness. In contrast, this experiment attempted to better reflect the overall concept of physical fitness by utilizing all components of the FITNESSGRAM.

The FITNESSGRAM classifies children as in or out of the Healthy Fitness Zone (HFZ). This occurs for each of the six tests to yield a ratio of tests passed in the HFZ to total tests administered. Because FITNESSGRAM does not generate an outcome beyond this ratio, these data were used to calculate a total fitness score for each student, based on the raw ratio data of number of fitness tests passed (i.e. in the healthy fitness zone) out of the possible six. Children passing five to six tests were classified as high fitness, those passing three to four tests were classified as moderate fitness and those passing zero to two tests were classified as low fitness. Total number of fitness tests passed has been correlated with cognitive test performance (Chomitz, 2009).

A challenge to this approach was that criteria for passing the PACER test at the third grade age group have not been established. Rather than eliminate third grade children – who are a primary target of physically active games - categorization was imputed based upon scores of those established for fourth and fifth grade children. That is, the difference in criteria between the fourth and fifth grades was applied in a linear fashion to the third grade data. As compared to fourth grade distribution of 27, 34, 39% in the low fitness, moderate fitness, and high fitness category and fifth grade distribution of 42, 37, 21% for the respective categories, the 3rd grade distribution was 15, 30, 55% for the low, moderate, and high fitness categories. To further examine the fitness variable, correlations were computed between PACER scores and components in HFZ (Table 3). These were broken out by grade because of the lack of clear criteria to interpret the 3rd grade PACER scores. As can be seen in the table, there is a positive correlation between PACER scores and components of HFZ, and the correlation reflected by the 3rd grade scores are within range of the 4th and 5th grades.

**Table 3. Correlations between PACER and Fitness Variable by Grade**

| *Grade* | *Components in HFZ* |
|---|---|
| 3rd | 0.41** |
| 4th | 0.25* |
| 5th | 0.54** |

*$* P < 0.05$, $**P < 0.01$*

Given the novel approach to calculating physical fitness it was further decided to examine these data for normality. Because data were transformed from ratio (yes/no in HFZ) to scaled data (number of tests in HFZ out of total tests) to categorical (fitness category), tests of normality were conducted to examine normal distribution of scores. Tests of normality indicated acceptable levels of skewness (-0.18 ±0.14) and kurtosis (-1. 45 ±0.29).

**Situational Interest**

Surveys were administered to measure the extent to which situational interest varied according to condition. (See Appendix L for survey.) Student interest ratings of each condition were measured using a single-item, 5-point likert-type question, with response scores ranging from 1 (“not at all liked”) to 5 (“liked a lot”). These were supplemented with a visual scale of faces depicting each point of the scale from 1 (frowning) to 5 (smiling). This scale was developed for this experiment and while it has no existing validity information, it is based on the use of facial expressions to capture mood-related constructs in children (Derbaix & Pecheux, 1999).

**Data and Statistical Analysis**

A 2 (pre-post) x 4 (condition) ANOVA with repeated-measures on the first factor was conducted for the analysis. With random assignment at the class-level, this results in a 3-level model: (1) condition, (2) nested within individual (pre-post) and (3) nested within class. This is problematic as the nesting violates that standard assumption of independent observations that underlie the general linear model. That is, the variance at the posttest is dependent, in part, upon the variance at the pretest. Likewise, TOT is likely to vary as a function of class dynamics as well as individual differences. Fortunately, there exist statistical procedures to account for this nesting.

The repeated measures framework was used to account for the within-subjects factors measured at the individual, pre and post level (i.e., TOT). However, the standard implementation of this analysis does not allow for the classroom level to be considered in the model. Therefore, a statistical procedure that controls for nesting effects at this level was necessary in the processing of these data. Accordingly, SAS PROC MIXED (SAS Institute, Inc., Cary, North Carolina) was used to control the covariance structure that this nesting imposes on the errors (Wolfinger & Chang, 1995). In this analysis, parameters were uniquely defined to identify error at the individual level for the repeated measure of time (pre- and posttest), the group level (of lesson condition) and at the class level. This model specification therefore allowed for the test of change in TOT between conditions while controlling for the effect of classroom nesting and accounting for the repeated measures.

Covariance parameter estimates were used to calculate intraclass correlations (ICCs) for TOT scores at pretest and posttest observations. ICCs due to class-level nesting at pretest were estimated at 0.20; and 0.29 at the posttest observation. Thus, 20% of the variance in pretest TOT scores was estimated to be due to between-class differences and 80% was due to individual differences within students. At the posttest observation, 29% of the observed variance in TOT was due to differences between classes and 71% was due to within-student differences. Thus, the utilization of statistical modeling controlling for clustering at the classroom level was supported for the current analysis.

*Hypothesis Testing*

The statistical analysis proceeded through a series of tests based on the apriori hypotheses. The initial test was done to verify the manipulation of physical activity intensity and interest in the lessons.

*Manipulation Check*

Physical Activity Intensity. Accelerometer data were used to calculate means values for METs, total activity counts, counts per minute and percentage of time spent in physical activity intensity categories by condition. The range of MET values and activity count cut points for each intensity category are displayed in Appendix N. A four group, univariate ANOVA was used to test for differences in these data. Significant differences were predicted, with post hoc tests used to determine where the differences exist.

Situational Interest. Although the measurement is based on 5 total responses on a single item, the underlying construct – interest in the lessons – represents a continuous variable. As such, a univariate ANOVA was used to determine mean differences in self-reported interest across lesson conditions. All three of the experimental conditions were predicted to be similar and yield greater enjoyment scores than the control condition, as tested by the main effect for interest.

**Outcome Variable**

**Time On-Task**

TOT was analyzed through the time by condition interaction using a two (time: pre-, post-lesson) x four (lesson condition) repeated measures analysis of variance (RMANOVA) on percentage TOT. A significant time by condition interaction was predicted. Simple effects were tested as the change over time for each of the experimental conditions and effect sizes calculated as Cohen's *d* statistic to determine the magnitude of effect.

**Moderators**

**BMI**

BMI was analyzed using a three-way (time [pre- vs. post-observation] x condition [control lesson, control game, LMPA game, MVPA game] x BMI category [normal, at-risk/overweight]) RMANOVA. Significant interactions were predicted and, if present, would be decomposed into the separate analyses as a function of BMI category. BMI was expected to moderate the effect of lesson condition on TOT, such that increases in TOT will be greatest post-MVPA condition, followed by post-LMPA condition, with the magnitude of effect greatest for children at-risk and overweight. TOT for children categorized in the normal BMI category was expected to increase post-MVPA condition, and to a lesser degree in LMPA condition, with a smaller magnitude of effect than those categorized as at-risk and overweight. TOT was expected to increase minimally post-inactive game, with a decrease in TOT post-inactive traditional lesson, with a linear magnitude of effect greatest for overweight, followed by at-risk, then normal weight category.

**Physical Fitness**

Overall physical fitness category was expected to moderate lesson condition effects on TOT. This was analyzed using a three-way (time [pre- vs. post-observation] x condition [control lesson, control game, LMPA game, MVPA game] x fitness category [low, moderate, high]) RMANOVA. Significant interactions were predicted and, if observed, would be decomposed into the separate analyses as a function of fitness category. It was expected that TOT would vary as a function of fitness level, such that children in the low fitness category would display the greatest impact for increased TOT in the MVPA condition, followed by the LMPA condition; and children in the moderate fitness category would display a similar, but to a lesser degree, pattern in TOT for the physically active conditions. Children categorized into the high fitness category were expected to display the greatest TOT increase after the MVPA condition, followed by the LMPA condition.

**Power Analysis**

It is difficult to assess power for two or more groups in a repeated-measures design, particularly those with nesting at a third level. As a result, an estimate of power was based on the smallest main effects (Cohen's *d*) from earlier work (Grieco, Jowers & Bartholomew, 2009) were conducted to determine sample size. With an effect size conservatively set to 0.19, alpha set to 0.05, and a desired power of 0.80 or greater, 215 participants are needed (G*Power 3, 2009; Erdfelder, Faul & Buchner, 1996). Although this does not specifically ensure sufficient power for the proposed design, it is a conservative estimate of a similar procedure. In addition, oversampling was employed to increase the number of at-risk and overweight children to test for moderation. Earlier work in the RRISD yielded a sample of 20% at-risk and 17% overweight children (Grieco, Jowers & Bartholomew, 2009). Thus, an additional 37% (80 children) of the recommended sample size of 215 was targeted at 295 children. Recruiting plans therefore targeted 20 classes (five per condition) to yield approximately 300 students (15/class; 75/condition), in line with previous recruitment efforts.

# CHAPTER 4
# RESULTS

The purpose of this study was to examine the effects of physically active academic lessons of varying intensity, set in a game-type format, on the on-task behavior of preadolescent children in the classroom setting. Research questions were designed to examine the extent to which TOT varied as a function of lesson condition; and to determine how this relationship varied as a function of children's BMI and fitness levels. The main variable of interest, time on-task (TOT), was measured pre- and post-lesson in each of the four conditions. TOT was hypothesized to vary according to condition, with effect sizes greatest for the moderate to high-intensity physically active game, followed by the low to moderate intensity physically active game, inactive academic game and inactive classroom lesson, respectively. Additionally, BMI and fitness were predicted to moderate this effect.

The results are organized accordingly: (1) baseline characteristics of the participants and examination of zero-order correlations between study variables; (2) manipulation checks for the dose of physical activity and situational interest; (3) hypothesis testing; and (4) follow-up analyses as suggested by unanticipated results. The hypothesis testing progresses through: (1) the main time x condition analysis to test the impact of condition on TOT from pre to post intervention; (2) the moderating effect of fitness on this pattern of effects; and (3) the moderating effect of BMI on this pattern of effects.

**Baseline Characteristics**

Study sample characteristics are presented in Table 4. Participants were 320 children aged 7 to 12 (mean = 9.5) years, with 51.2% female. No differences in demographic variables existed at baseline between conditions for BMI category ($\chi^2_{6, 299}$ = 6.67, $P > 0.05$), fitness category ($\chi^2_{6, 305} = 4.36$, $P > 0.05$) or gender ($\chi^2_{3, 320} = 1.53$, $P > 0.05$). Differences between conditions existed for age ($\chi^2_{15, 320} = 47.62$, $P < 0.001$) and grade ($\chi^2_{6, 320} = 65.33$, $P < 0.001$).

Table 4. Descriptive Characteristics for Participants by Condition (*n* = 320)

| *Variable* | *Control Lesson* | *Control Game* | *LMPA Game* | *MVPA Game* | *Total* |
|---|---|---|---|---|---|
| Age, μ (*SD*), years** | 9.8 (±0.9) | 9.2 (±1.0) | 9.8 (±0.8) | 9.1 (±0.9) | 9.5 (±0.9) |
| Gender | | | | | |
| Female | 38 | 45 | 38 | 43 | 164 |
| Male | 38 | 42 | 43 | 33 | 156 |
| Total | 76 | 87 | 81 | 76 | 320 |
| Grade* | | | | | |
| 3rd | 10 | 48 | 10 | 35 | 103 |
| 4th | 28 | 15 | 36 | 30 | 109 |
| 5th | 36 | 24 | 35 | 11 | 108 |
| Total | 76 | 87 | 81 | 76 | 320 |
| Body mass index % | | | | | |
| Normal | 45 | 61 | 53 | 53 | 212 |
| At-risk | 16 | 10 | 10 | 7 | 43 |
| Overweight | 9 | 10 | 12 | 13 | 44 |
| Total | 70 | 81 | 78 | 73 | 299 |
| Fitness Category, % | | | | | |
| Low | 25 | 20 | 22 | 19 | 86 |
| Moderate | 21 | 26 | 30 | 26 | 103 |
| High | 26 | 36 | 25 | 29 | 116 |
| Total | 72 | 82 | 77 | 74 | 305 |

*Significant between condition difference, P < 0.05, **Significant between condition difference, P < 0.001

## Correlation Matrix

Bivariate correlations among study variables are displayed in Table 5. BMI and fitness were strongly correlated. This is not surprising, as BMI is a component of the fitness categorization as derived by the FITNESSGRAM. Likewise, the strong correlation between METS and Total Counts is not surprising as the calculation of the former is dependent upon the latter. There was also a positive relationship between activity counts and situational interest, indicating that children enjoyed the more active lessons more than the sedentary lessons. The lack of correlation with post-TOT with any variable other than MET and Total Counts is surprising. The lack of correlation with pre-TOT indicates that TOT in this sample is not overly influenced by individual differences and thus, not consistent over time. In addition, given the effects of physical activity on cognitive function one would expect both fitness and BMI to be correlated with the pre-TOT at a minimum. Again, it may be that TOT in this sample is more reflective of situational than individual influences. This will be addressed to a greater extent in the discussion and follow-up analyses.

**Table 5.** Pearson Product Moment Correlation Coefficients for percentage TOT pre-observation, TOT post-observation, METs, Total Counts, Situational Interest, BMI Category and Fitness Category

| | **Pre-TOT** | **Post-TOT** | **METs** | **Total Counts/Min** | **Situational Interest** | **BMI Category** | **Fitness Category** |
|---|---|---|---|---|---|---|---|
| **Pre-TOT** | 1.00 | 0.13* | 0.31** | 0.31** | 0.07 | -0.01 | -0.07 |
| **Post-TOT** | | 1.00 | -0.16** | -0.19** | -0.06 | -0.10 | -0.08 |
| **METs** | | | 1.00 | 0.97** | 0.26** | 0.05 | 0.01 |
| **Counts/Min** | | | | 1.00 | 0.26** | 0.06 | 0.02 |
| **Enjoyment** | | | | | 1.00 | -0.03 | 0.09 |
| **BMI Category** | | | | | | 1.00 | -0.54** |
| **Fitness Category** | | | | | | | 1.00 |

*$P < 0.05$, **$P < 0.01$

## Manipulation Check

### Physical Activity Intensity

Accelerometer data were used to assess the physical activity manipulation. Means values for METs, total counts, counts per minute and percentage of time spent in physical activity intensity categories by condition are presented in Table 6. These outcomes were averaged across children in each condition. MET range and activity count cut points for intensity categories are displayed in Appendix N. Trends emerged such that physical activity conditions yielded significantly ($P < 0.001$) higher, average intensities than the control conditions; and the MVPA condition over the LMPA condition. No significant differences ($P > 0.10$) in intensity categories existed between control conditions. As such, physical activity levels for each condition yielded values in concert with targeted intensities. Specifically, the children in the control lesson and game spent more than 90% of their time in sedentary or light activity, with average MET value of less than 2. The children in the LMPA condition spent 88% of their time in LMPA, with an average MET value of 3.8. Finally, the children in the MVPA condition spent 83% of their time in MVPA, with an average MET value of 5.6.

**Table 6.** Physical Activity Outputs by Condition

| *Condition* | *Avg. METs* | *Total Counts* | *Counts per Minute* | *Time (%) in Sedentary* | *Time (%) SLPA* | *Time (%) in LPA* | *Time (%) in MPA* | *Time (%) in VPA* | *Time (%) in LMPA* | *Time (%) in MVPA* |
|---|---|---|---|---|---|---|---|---|---|---|
| Control lesson | 1.3 | 1852 | 154 | 73.6 | 97.4 | 23.9 | 2.6 | 0 | 26.5 | 2.6 |
| Control game | 1.8 | 4694 | 391 | 46.7 | 90.8 | 43.9 | 9.2 | 0 | 53.1 | 9.3 |
| LMPA game | 3.8 | 23501 | 1958 | 4.3 | 32.2 | 28.0 | 59.7 | 7.8 | 87.8 | 67.8 |
| MVPA game | 5.6 | 47346 | 3946 | 6.2 | 16.2 | 10.1 | 44.7 | 39 | 54.8 | 83.8 |

Abbreviations: METs, Metabolic Equivalents; SLPA, sedentary/light intensity physical activity; LPA, light intensity physical activity; MPA, moderate intensity physical activity; VPA, vigorous intensity physical activity, CCPA, very vigorous intensity physical activity; LMPA, low/moderate intensity physical activity; LMPA, low/moderate intensity physical activity.

## Situational Interest

A univariate analysis on situational interest ratings indicated a significant difference among conditions ($F_{3, 307} = 6.89$, $P < 0.001$). Post hoc tests indicated significant mean differences in interest rating between the control lesson and the LMPA game ($P < 0.05$) and MVPA game ($P < 0.001$); and the control game and the MVPA game ($P < 0.05$). Specifically, children rated their interest in the control lesson 0.53

points lower than the LMPA game and 0.75 points lower than the MVPA game. Additionally, children reported interest in the control game 0.51 points lower than the MVPA game. Means and standard deviations for interest ratings are presented in Table 7. Because of the differing interest ratings between conditions, tests for moderation were conducted to further examine the effect of situational interest on the main outcome variable of TOT. These analyses are reported in the section to follow entitled, "Assessment of Proposed Moderators."

**Table 7**. Means and Standard Deviations for Situational Interest (N = 320)

| Condition | Situational Interest Rating |
|---|---|
| Control lesson[a] | 3.5 (±1.0) |
| Control game [a, b] | 3.7 (±1.2) |
| LMPA game[b, c] | 4.0 (±0.9) |
| MVPA game[c] | 4.2 (±1.1) |

Means sharing a common superscript are do not differ at $P < 0.05$.

## Hypothesis Testing

### Time On-task (TOT)

A two-way (time: pre- vs. post-observation x condition [control, control game, LMPA game, MVPA game]) mixed-methods RMANOVA compared TOT between observation periods. This analysis revealed the hypothesized (Hypothe, significant time by condition interaction ($F_{3,316} = 19.32$, $P < 0.001$). Main effects were significant for time ($F_{3,316} = -8.83$, $P < 0.01$) and condition ($F_{3,316} = 7.89$, $P < 0.001$). In order to examine the nature of the interaction, post hoc tests on the repeated measure of time within each condition were conducted. The resulting simple effects were in the predicted pattern of results. Specifically, TOT decreased significantly from pre- to post- in the control lesson condition ($t_{3,316} = 3.85$, $P < 0.001$), showed no pre-, post- change in the control game condition ($t_{3,316} = 0.41$, $P = 0.68$), and increased significantly from pre- to post- in the

LMPA game ($t_{3,316}$ = 2.70, $P < 0.01$) and MVPA game ($t_{3,316}$ = 6.66, $P < 0.001$) conditions. Means, standard deviations and effect sizes (Cohen's *d*) across all students for TOT are presented in Table 8. Changes in TOT across conditions are illustrated in figure 1.

Due to the large difference in pre-test TOT observed in the MVPA condition, the decision was made to run an analysis to attempt to statistically account for observed differences. Accordingly, univariate analyses were conducted on posttest TOT, covarying pre-test TOT. This analysis indicated that the percentage of TOT at the posttest was significantly different between conditions ($F_{3,274}$ = 7.82, $P < 0.001$). Posttest TOT was significantly lower following the control lesson than TOT following: the control game (t = -2.21, $P < 0.05$), the LMPA game ($t$ = -3.72, $P < 0.001$), and the MVPA game (t = -4.49, $P < 0.001$). In addition, TOT following the control game was lower than TOT following the LMPA game (t = -1.54, P = 0.13) and the MVPA game (t = -2.34, $P < 0.05$); and, TOT following the LMPA game was no different than TOT following the MVPA game (t = -0.80, $P$ = 0.42). Thus, despite the large difference in effect sizes between the LMPA (0.43) and the MVPA (1.22) conditions, no difference in posttest TOT was supported once pre-test scores were controlled.

**Table 8**. Means, standard deviations and effect sizes for percentage TOT for all students (N = 320)

| | **Pre-** | **Post-** | **Effect Size (*d*)** |
|---|---|---|---|
| Control lesson* ° ᵗ | 69.8 (±23.3) | 54.5(±26.5)*** | -0.61 |
| Control game* # | 67.8 (±26.0) | 69.3 (±27.6) | 0.06 |
| LMPA game° | 70.4 (±24.3) | 80.7 (±23.9)** | 0.43 |
| MVPA gameᵗ # | 56.2 (±23.6) | 82.7 (±19.6)*** | 1.22 |

*Significant difference between conditions, $P < .05$. °Significant difference between conditions, $P < .001$. ᵗSignificant difference between conditions, $P < .0001$. #Significant difference between conditions, $P < .05$. ** Significant pre-, post-difference, $P < .01$. *** Significant pre-, post-difference, $P < .0001$.

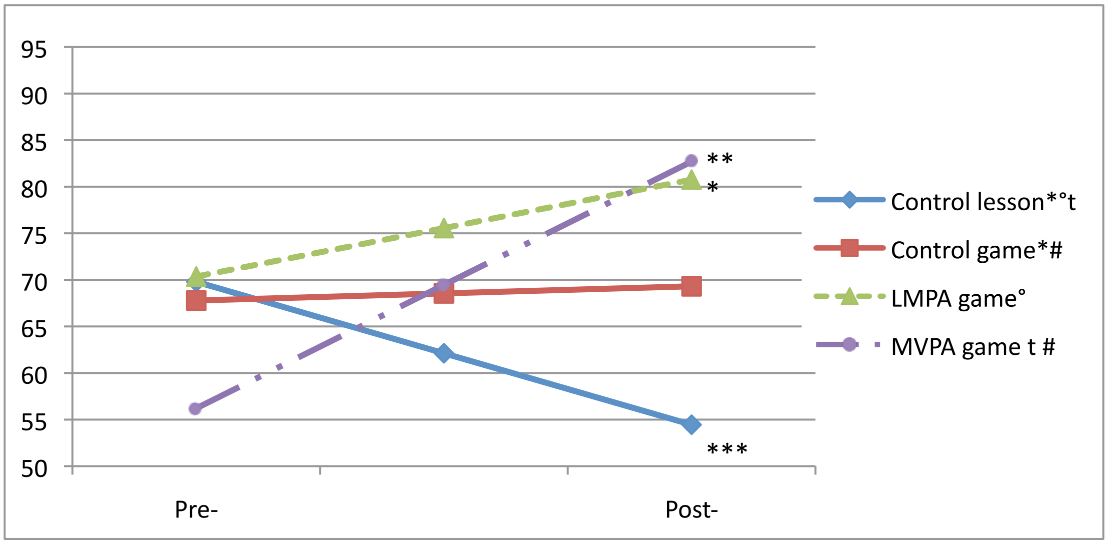


**Figure 1**. Mean percentage of TOT for each condition.
*Significant difference between conditions, $P < 0.05$. °Significant difference between conditions, $P <$ 0.001. ·Significant difference between conditions, $P < 0.001$. ·Significant difference between conditions, $P$ $< 0.05$. ** Significant pre-, post-difference, $P < 0.01$. *** Significant pre-, post-difference, $P < 0.001$.

**Assessment of Proposed Moderators**

**BMI**

BMI was hypothesized to moderate the effect of physical activity on TOT. This was analyzed through a three-way (time [pre- vs. post-observation] x condition [control lesson, control game, LMPA game, MVPA game] x BMI category [normal, at-risk, overweight]) mixed-methods RMANOVA comparing TOT between observation periods. No significant interaction was detected ($F_{6,287} = 0.71$ $P = 0.64$). The distribution of BMI was non-normal, with the majority of participants (70%) in the normal category. While it is not possible to apply a transformation to categorical data, it is possible to collapse similar categories to provide for a more powerful assessment. To this end, a subsequent RMANOVA was conducted collapsing the at-risk and overweight categories to decrease the chance of type 2 error due to a potentially underpowered sample of high BMI category children. However, this interaction was similarly not significant ($F_{3, 291}= 0.85$,

$P$ = 0.47), with a pattern of effects similar to the three-group analysis. Given the continued concern for low power, means, standard deviations and effect sizes (Cohen's *d*) for TOT for all three BMI categories are presented in Table 9 to allow the reader to visually inspect the effect.

A visual inspection of these data coincides with both the lack of statistical differences and the lack of a correlation between BMI and either pre- or post TOT as presented earlier. That is, while there appear to be differences within conditions there does not seem to be a consistent pattern across either the control or active conditions. Specifically, TOT decreased from pre- to post across all BMI categories in the control lesson condition. The magnitude of effect was moderate for the normal BMI children and small for those in the at-risk and overweight categories. In the control game condition, TOT decreased slightly among normal and at-risk children and increased moderately in the overweight category. TOT following the LMPA game increased across all categories, with a moderate effect for normal weight children and a smaller effect for those in the at-risk and overweight categories. Following participation in the MVPA game, TOT increased across all children, with normal and at-risk children experiencing a greater impact than overweight children. Again, this does not suggest a clear, over-riding pattern for BMI and TOT by condition, and the null effects do not appear to be due to a lack of power.

**Table 9**. Means and standard deviations for percentage TOT by BMI category

| | Pre- | Post- | Effect Size (*d*) |
|---|---|---|---|
| Control lesson | | | |
| Normal | 69.1 (±25.6) | 50.7 (±25.5) | -0.72 |
| At-risk | 69.6 (±17.2) | 62.8 (±29.8) | -0.28 |
| Overweight | 67.6 (±23.5) | 62.4 (±18.2) | -0.25 |
| Control game | | | |
| Normal | 68.9 (±25.6) | 67.4 (±28.7) | -0.06 |
| At-risk | 75.8 (±16.5) | 74.9 (±30.6) | -0.04 |
| Overweight | 52.0 (±32.5) | 70.6 (±23.4) | 0.66 |
| LMPA game | | | |
| Normal | 71.3 (±23.0) | 83.0 (±22.5) | 0.51 |
| At-risk | 74.6 (±14.9) | 79.1 (±23.3) | 0.23 |
| Overweight | 61.1 (±31.7) | 73.2 (±32.7) | 0.37 |
| MVPA game | | | |
| Normal | 57.2 (±25.1) | 84.5 (±17.3) | 1.27 |
| At-risk | 56.1 (±25.3) | 84.9 (±13.8) | 1.14 |
| Overweight | 50.7 (±16.9) | 73.2 (±29.9) | 0.93 |

**Fitness**

Fitness was also hypothesized to moderate the impact of physical activity on the change in TOT. A three-way (time [pre- vs. post-observation] x condition [control, control game, LMPA game, MVPA game] x fitness category [low, moderate, high]) mixed-methods RMANOVA compared TOT between observation periods and revealed no significant three-way interaction ($F_{6,293} = 1.28$, $P = 0.27$). Means, standard deviations and effect sizes (Cohen's *d*) for TOT by fitness category are presented in Table 10.

**Table 10**. Means and standard deviations for percentage TOT by fitness category

| Condition | Pre- | Post- | Effect Size (*d*) |
|---|---|---|---|
| Control lesson | | | |
| Low | 69.3 (±20.1) | 57.5 (±25.0) | -0.52 |
| Moderate | 73.7 (±24.9) | 61.7 (±27.2) | -0.46 |
| High | 64.6 (±25.4) | 47.8 (±24.5) | -0.67 |
| Control game | | | |
| Low | 74.7 (±21.1) | 73.9 (±29.4) | -0.31 |
| Moderate | 74.5 (±27.6) | 65.0 (±32.6) | -0.32 |
| High | 59.8 (±25.9) | 69.4 (±24.2) | 0.38 |
| LMPA game | | | |
| Low | 70.8 (±29.9) | 85.8 (±22.3) | 0.57 |
| Moderate | 70.2 (±22.2) | 80.5 (±23.7) | 0.45 |
| High | 72.1 (±20.9) | 78.5 (±26.8) | 0.26 |
| MVPA game | | | |
| Low | 55.5 (±23.1) | 79.3 (±26.4) | 0.96 |
| Moderate | 53.7 (±26.5) | 87.6 (±14.2) | 1.60 |
| High | 59.5 (±22.5) | 80.4 (±19.1) | 1.00 |

In comparison with the BMI data, the distribution of fitness categories was relatively even, with each group (low, moderate and high fitness) near 30% of the total sample. The percentage of TOT appeared to decrease with a moderate impact across all children following the control lesson, regardless of fitness category. Children of low and moderate levels of fitness experienced a small decrease in TOT following the control game, whereas high fitness children showed a moderate increase in TOT. Following the LMPA game, children at low and moderate levels of fitness experienced a moderate increase in TOT, versus a small increase for high fit following the MVPA game. Again, there was no overriding pattern of effects and the null-effects appear to not reflect a lack of power.

**Situational Interest**

Given the observed differences in self-reported situational interest between conditions, the decision was made to test if interest moderated the effect of condition on TOT. To avoid low response rates in any individual category, situational interest was recoded from the 1 to 5 scale of student reported ratings designed to reflect the underlying construct of interest in the lesson. Scores of 1 and 2 were coded as "dislike," a score of 3 was coded as "neutral," and scores of 3 and 4 were coded as "like." These were selected as they represent the natural categories that are represented in the 5 point scale. Thus, the test for moderation consisted of a 2 (time [pre- vs. post-observation]) x 4 (condition [control, control game, LMPA game, MVPA game]) x 3 (situational interest category [dislike, neutral, like]) RMANOVA on percentage TOT. The three-way interaction was not significant ($F_{6,295} = 1.55$, $P > 0.10$). The main effect for interest category by condition was also not significant ($F_{6, 295} = 0.93$, $P > 0.10$). This analysis was repeated using the original scale of situational interest (ranging from 1 to 5) and similarly yielded a non-significant time by condition by interest interaction ($F_{12, 237} = 1.09$, $P > 0.10$).

The mean percentages of TOT at pre-test and posttest by interest category across all conditions is reported in Table 11 and the percentage TOT at pre-test and posttest within each condition are reported in Table 12. An inspection of these data indicate that while situational interest varied between conditions as reported in the "Manipulation Check" section of the analysis, differences in student interest did not moderate students' TOT response.

**Table 11. Percentage TOT as a function of Situational Interest Rating across all Conditions**

| | ***Pre-test TOT*** | ***Posttest TOT*** |
|---|---|---|
| Dislike | 71.6 (±27.4) | 70.4 (±26.1) |
| Neutral | 65.3 (±26.9) | 67.7 (±30.7) |
| Like | 66.0 (±23.5) | 72.8 (±25.7) |

**Table 12. Percentage TOT as a function of Situational Interest Rating by Condition**

| | *Pre-test TOT* | *Posttest TOT* |
|---|---|---|
| Control Lesson | | |
| Dislike | 74.6 (±22.0) | 61.6 (±21.6) |
| Neutral | 72.7 (±23.8) | 48.0 (±30.3) |
| Like | 66.6 (±23.5) | 55.0 (±26.1) |
| Control Game | | |
| Dislike | 76.1 (±29.8) | 67.4 (±32.4) |
| Neutral | 69.4 (±24.0) | 69.2 (±30.9) |
| Like | 65.4 (±25.9) | 70.2 (±25.6) |
| LMPA Game | | |
| Dislike | 79.5 (±24.0) | 93.6 (±10.6) |
| Neutral | 62.8 (±35.2) | 83.5 (±18.6) |
| Like | 71.3 (±21.2) | 78.7 (±23.7) |
| MVPA Game | | |
| Dislike | 34.2(±18.6) | 79.0 (±15.4) |
| Neutral | 49.1 (±23.7) | 81.9 (±24.1) |
| Like | 60.1 (±22.5) | 82.3 (±19.9) |

# CHAPTER 5
# DISCUSSION

The present study was designed to assess the possibility that there exists a dose-response of physical activity on the change in attentional control in pre-adolescent children. Physical activity was incorporated into academic lessons for children in the classroom and compared to an inactive control that was based on individual, seated academic lessons. A second inactive, competitive lesson was added to address the possibility that the benefits of physical activity are merely due the children's enjoyment of playing a game. Results indicated that the students' TOT decreased significantly after a traditional seated control lesson. TOT did not change following the inactive control game. Thus, the competitive, seated game was sufficient to prevent the reduction in TOT that followed the traditional, seated control. In contrast, both physically active games were sufficient to increase TOT. Both had a significant increase in TOT relative to each control condition. In addition, the effect of the MVPA game was nearly three times the effect of the LMPA game.

These findings suggest there may be some benefit for a game-type format regardless of intensity as the control game outperformed the traditional, control lesson. This provides support for theories of attentional reset (Evans & Pellegrini, 1997). The control game was sufficient to provide a break from a routine, traditional lesson, thereby possibly providing an opportunity for an attentional shift sufficient to allow children to refocus attention during subsequent lessons. Post-lesson increases in TOT may result from a replenishment of self-regulatory processes (Muraven & Baumeister, 2000); that is, the academic game provided the kind of break that provided an opportunity for recovery so that children can better control attention later. That is, the processes and actions required throughout the school day are likely to deplete children's self-regulatory control through continual exertion of this resource. Implementation of an academic lesson in a game-type format, then, frees up self-control processes required for engagement in routine lessons. This may allow for an increase in regulatory control for subsequent lessons; translating to improved behavior during subsequent lessons.

Despite the benefit of the inactive game, there is a large, further benefit (ES = 0.43 for LMPA; ES = 1.22 for MVPA) of adding physical activity to the lessons/games. Both the LMPA and MVPA conditions had significant increases in TOT compared to no change for the sedentary game. These findings are in line with Mahar et al.'s (2006) research, which showed increases in TOT following physically active lessons, but are in contrast to previous findings (Grieco, Jowers, & Bartholomew, 2009) which showed physically active lessons to merely prevent the decrease in TOT observed following inactive lessons. These differences may be explained by an examination of baseline TOT scores in each study. Mahar (2006) showed an increase in TOT percentage from 70.9 (±15.3) to 79.2(±11.4) in the physically active break condition compared to a decrease in TOT following an inactive control lesson from 71.3(±16.3) to 68.2(±14.5) % TOT. Results from Grieco, Jowers, & Bartholomew (2009) showed no change in TOT following an active lesson, with 87.4(±14.8) % TOT at pre-test, and 90.2(±12.4)% TOT at posttest, compared to a significant decrease in TOT following an inactive control, from 84(±16.5) to 68.2(±23.2) % TOT. It may be that the high TOT values at pre-test for the active condition in our previous work (87% TOT; Grieco, Jowers, & Bartholomew, 2009) prevented the larger relative gain observed in the current study and Mahar's (2006) study where pre-test values were at 65% and 71% TOT respectively. To better test this possibility, future research should examine the impact of active, academic lessons as a function of pre-test TOT values.

Although the effect size was much larger in the MVPA than the LMPA condition, the posttest values were similar. This may be due to significantly lower pre-test TOT for the MVPA condition (MVPA=56.21(± 23.6); LMPA=70.36(±23.61)). This difference occurred despite the fact that classes were randomly assigned to conditions. Regardless of the cause, it is important not to place too high a value on the dose-response for physical activity intensity as it may be that the LMPA condition merely reached a ceiling. Although previous studies have shown a higher percentage of TOT (e.g., Grieco, Jowers, & Bartholomew, 2009) following active lessons, this remains a concern. As such, the relative differences between the MPVA and the LMPA conditions should be interpreted with caution until replicated.

This should not be interpreted to mean that physical activity provided no benefit. Both physically active conditions produced significant increases in TOT, compared to no change for the inactive game and a significant reduction for controls. As such, it is clear that physical activity is important to include if the effect of these lessons is to maximize the resulting TOT. However, it is not clear which dose of physical activity is required to maximize this effect. Given the benefit of physical activity over both the traditional, seated lesson and the inactive game controls, these data can be used to infer that there is a benefit to physical activity beyond merely providing an enjoyable break from study. There is clear public health relevance in terms of providing children opportunities to engage in physical activity. Utilization of physically active lessons not only provides on-task behavioral benefits, but also moves children closer to obtaining the recommended dose of physical activity necessary for health benefits.

Although arousal was not assessed in this experiment, the results support theories of acute change in arousal for increasing post-physical activity attention. These findings provide evidence for the hypothesis that with increases in physical activity intensity, central nervous system activity also increases, which facilitates cognitive functioning. These are in line with previous studies that have shown improvements in cognitive control following physical activity in children (Hillman et al., 2009b). The greater magnitude of effect in the MVPA condition, over the LMPA condition, are not in line with previous work that suggests cognitive functioning improves up to a point (e.g., Kashihara et al. 2009), then attenuates following high-intensity physical activity at or approaching lactate threshold (e.g., Chmura et al., 1994). However, it may be that in the present study children did not reach intensity levels high enough to elicit lactate threshold and thus did not show decrements, but rather improvements in TOT following the MVPA lesson. Future research could more fully explore these effects by directly assessing the change in arousal as well as utilizing a more vigorous level of physical activity.

**BMI and Fitness**

Hypotheses of the moderating effects of BMI and fitness on TOT were not supported. Neither BMI nor fitness had an impact at either pre-test values or TOT following conditions. This may be due to situational factors, rather than individual factors, as there was no correlation with pre-TOT, fitness category, PACER or BMI; as the drop in TOT over time across the control group further support this interpretation. Furthermore, interest in the MVPA game was high across high BMI and low fit children.

This may not be the case at very high doses of physical activity (intensity or duration), as this remains a topic that future studies should examine.

This absence of a moderating effect of BMI on TOT differs from previous studies (Grieco, Jowers, & Bartholomew, 2009), where those with higher BMI experienced the greatest benefit in TOT. Results of our previous study indicated pre-test TOT was 87.41(±14.8) in the active condition and 84(±16.47) in the control condition. The change in TOT from pre- to postlesson had the greatest effect on those children at risk and overweight (*d*=0.26 in the active condition; *d*=-0.98 in the control condition), compared to the normal weight children (*d*=0.13 for active condition; *d*= -0.39 for control condition). Thus, groups had a greater difference in pre-test TOT in our last study as compared to the current study, in which scores were quite similar. This sample did not contain a large number of children categorized as overweight, which lowered the ability to test for moderation. Although the observed effects did not suggest a significant pattern of effects, this remains a limitation until a more powerful assessment is utilized.

Likewise, the failure to support a difference with fitness was also surprising. Although no past studies have investigated the relationship of fitness on on-task behavior specifically, those examining the relationship of fitness on related outcomes - such as cognitive functioning and academic performance - have found significant effects (e.g., Hillman, Castelli, & Buck, 2005); Castelli, Hillman, Buck, & Erwin, 2007). However, in Castelli et al.'s (2007) study, test performance improved as a function of aerobic fitness specifically, and no effect was shown for tests of muscular strength and flexibility. Because the fitness measure utilized in the present study incorporated tests of strength and flexibility in the composite variable of overall fitness, it may be that the effect of fitness on TOT was diminished.

Again, fitness effects may only occur with a greater dose of physical activity, i.e. more intense or longer lasting. This interpretation is supported by the fact that while not significantly different, the MVPA condition received the highest enjoyment ratings. One would expect those children low in fitness to not enjoy more intense physical activity. It may require more intense or longer lasting physical activity to fully test this possibility.

**Strengths and Limitations**

The strengths of this study included the use of objective measures of physical activity and of TOT, as this was the first study to do so. Thus, the results are likely to provide a more accurate test of the hypothesis than if a less objective measure of physical activity was used. In addition, past studies have shown wide variability in teacher implementation of physically active lessons (e.g., Donnelly et al., 2009). In the present study the investigator implemented all lessons, which allows for a more consistent experience of physical activity within each condition. Although this leaves questionable the ability of teachers to implement these lessons in the absence of project staff, our previous studies indicate otherwise (Grieco et al., 2009). In our past work teachers were trained and observed periodically throughout the study. Fidelity to lesson protocol was acceptable and implementation rates were high, at 94%. Thus, trained teachers were able to conduct these lessons independently.

A primary limitation includes no assessment of behavioral problems. The district would not release the data on or pertaining to behavioral problems (e.g. referrals to administration, document behavioral problems, etc.). Future studies would do well to investigate the potential moderating role of pre-existing behavioral conditions. Indeed, Mahar (2006) found physically active lessons to have the greatest impact ($d$=2.20, $P$ <0.05) on a subsample (n=10) of the least on-task students. Given these and current study findings of the large, significant effect size for TOT following a MVPA lesson, it may well be that the least on-task population would derive the greatest benefit from the usage of physically active lessons at a moderate-to-vigorous intensity.

In addition, the present study was limited in that it only tested the effects of behavior for 15-minutes following the lesson. This could have been corrected through additional assessments of TOT, but multiple observations of the same class were thought to compromise already limited schedules. This is important, as the single assessment of post-intervention TOT does not allow for an assessment of attentional decay. Both this and the previous study (Grieco, Jowers & Bartholomew, 2009) indicated that TOT was highly variable, declining by a 15 percentage points over 45 minutes in the control groups. It could be that following the physically active lessons, TOT would decline at a reduced rate over time compared with the inactive game and the control lessons – which would provide a strong argument for including a physical activity component. Likewise, because physical activity resulted in high TOT, even a decline at a similar rate to the inactive game would maintain TOT at a higher rate for a longer period. If this is the case, one would expect an inactive game/lesson to require more implementations throughout the day to maintain TOT than a physically active lesson. Such a finding, though beyond the scope of this experiment, would provide further support for this intervention and is an important next step in the evaluation of these lessons.

These data are also limited by the method of categorizing fitness, which was developed for this experiment and not previously validated. There are two concerns with the approach taken: the cut points for the PACER test, and the categorization based on tests passed in the Healthy Fitness Zone. This may undermine the test of fitness as a moderator. However, the cut-points for PACER test was based on the 4$^{th}$ and 5$^{th}$ grade protocol and resulted in a similar distribution of scores. In addition, while the categories used in this experiment were novel, the use of total tests passed has been associated with tests of cognitive performance (Chomitz, 2009). Thus, it is not an unprecedented approach. Regardless, while these efforts were made to better utilize the full FITNESSGRAM data, they must be further validated or risk over-interpreting these data.

Finally, additional limitations of this study include the pretest TOT differences in the MVPA condition. Although classes were randomly assigned to conditions, failure of random assignment may render differences between conditions equivocal. However, comparisons between the LMPA and the control, sedentary game allow for a strong test of physical activity. These groups had very similar pre-test TOT and enjoyment ratings, with large differences in physical activity counts. Given the observed difference in posttest TOT between these conditions, we can be confident in the unique benefit provided by physical activity on subsequent TOT.

**Future Research and Implications**

Future studies should extend these findings to investigate the length of improvement following the physically active lessons, as well as their relationship of physical activity and student engagement with respect to academic performance. Although the ability to attend to the task at hand is believed to be integral to learning and academic performance, these relationships should be directly measured in future, randomized controlled studies as positive effects would provide a much stronger justification for the use of these lessons in the elementary classroom.

These findings have clear implications. Modifying student behavior through usage of physically active academic lessons has the potential to enhance learning by both increasing on-task behavior during academic instruction and decreasing behavioral disruptions throughout the school day. Evidence for the dose-response of physical activity is particularly useful in that by implementing these lessons at a higher intensity, children will improve on-task behavior; and be provided additional opportunities for more efficient physical activity engagement. This, obviously, comes at a cost to the teacher in the disruption of the class day by moving desks or moving the students outside. Given the benefit of inactive games, one might argue that these are sufficient for TOT regulation. However, the relatively larger change in TOT follow LMPA, and the especially large change following MVPA, would suggest that the effort required to implement more intense active games is worth the extra effort. The immediacy of these positive behavioral effects may serve to increase motivation among teachers to implement physically active lessons, in conjunction with the well-established focus on the distal benefits associated with physical activity. Thus, in addition to increasing physical activity, teachers may well use active lessons to modify behavior and maximize learning time among students. As a result, these findings may be extended to the application of physical activity promotion through providing children the dual benefit of improved academic engagement and increased time in physical activity pursuits.

Appendices

Appendix A – Principal Letter

FOREST CREEK ELEMENTARY
3505 Forest Creek Dr
Round Rock, TX 78664
Phone 512.464.5450    Fax   512.464.5430

Sheri Lehnick – Principal    Karen Leitch - Counselor
Karen Lunkin – Assistant Principal
Mary Graf – Counselor

February 12, 2011

Dear Parent,

*Forest Creek Elementary School* is excited about the opportunity to partner with the Texas ICAN! (Initiatives for Children's Activity and Nutrition) study this Spring. The purpose of this study is to examine the improvements in classroom behavior from academic lessons that incorporate physical activity. This project is approved by the district and we support our students' participation in the study.

Please view and sign the attached consent forms and return them in your students' folders.

Sincerely,

Sheri L. Lehnick

Sheri Lehnick

Principal, Forest Creek Elementary

Appendix B – Parental Consent Form

# Informed Consent to Participate in Research

**The University of Texas at Austin**

***Physically Active, Academic Lessons and On-task Behavior in Preadolescent Children: Effects of Intensity and Volume***

Your son/daughter is invited to participate in a study of children's activity. My name is Lauren Grieco and I am a Ph.D. Candidate at The University of Texas at Austin, Department of Kinesiology. This study is part of my research involving physical activity in school-aged children. I am asking for permission to include your son/daughter in this study because they are in the 3rd, 4th or 5th grade at **Forest Creek Elementary**. I expect to have 200 participants in the study.

**Title of Research Study:** ***Physically Active, Academic Lessons and On-task Behavior in Preadolescent Children: Effects of Intensity and Volume***

**Principal Investigator(s) (include faculty sponsor), UT affiliation, and Telephone Number(s):** Lauren A. Grieco, M.A., 512-232-6054 and John B. Bartholomew, Ph.D., Associate Professor, Department of Kinesiology & Health Education; 512-232-6021.

**Funding source:** N/A

**What is the purpose of this study?** The overall goal of the study is to determine how effective physical activity is in increasing ability to focus and stay on-task in 3rd, 4th, and 5th grade children.

**What will be done if you allow your child to participate in this research study?** If you allow your child to participate, your child will be asked to 1) wear an accelerometer (small device that measures physical activity) and be observed during four 15 minute lessons and 2) be measured for height and weight in the presence of the school nurse. In addition, we will ask the school to provide demographic data (age, ethnicity, gender) for each student. All data will be kept confidential.

**The Project Duration is:** The project will begin September 1, 2010 and will end on the last semester day in December 2010.

**What are the possible discomforts and risks to your child?** Possible discomfort may occur if a child feels anxious about being measured for height and weight or wearing an accelerometer. In our previous experience working with children, we have found that because the school nurse measures them for height and weight each year, students are used to being measured. Accelerometers are often a favorite item for children to use and they use them as part of P.E. class in some schools. If a child feels uncomfortable at any time, s/he can tell his/her teacher, the nurse, or our project staff and s/he will be excused from participating. If you wish to discuss the information above or any other risks you may experience, you may ask questions now or call the principal investigator listed on the front page of this form. Children may become physically injured (minor injuries such as a bruised shin) as a result of participating in the physical activity lessons in class. All injuries will be reported to the nurse, the principal investigator, the sponsor, and the University of Texas Institutional Review Board (UT IRB). The physical risk is not expected to be more than any risk a child faces during school recess or P.E. class.

**What are the possible benefits to your child or to other children?** There are no direct benefits to either the student or teacher participants. However, there are clear potential benefits to society at large. This intervention represents an attempt to improve focusing ability and on-task behavior in children.

**If you choose for your child to take part in this study, will it cost you anything?** Participation in this project is free of charge to all participants. Any supplies needed for participation will be provided to the child at no charge.

**Will you or your child receive compensation for participation in this study?** Students will receive a pencil for returning this consent form, whether or not they are allowed to participate. The University has no plan to provide compensation for a physical or psychological injury.

**What if your child is injured because of the study?** No injuries are anticipated. The University has no program or plan to provide treatment for research related injury or payment in the event of a medical problem. In the event of a research related injury, please contact the principal investigator.

**If you do not want your child to take part in this study, what other options are available to your child?** Your child's participation in this study is entirely voluntary. You are free to refuse your child's participation, and your refusal will not influence current or future relationships with The University of Texas at Austin, **Forest Creek Elementary** and/or Round Rock Independent School District (RRISD).

How can you withdraw your child from this research study and whom should you call if you have questions? **If you or your child wishes to withdraw from this study at any time or if you have questions at any time, you should contact the principal investigator, Lauren A. Grieco, at: 512-232-6054.**

**If you wish to stop your child's participation in this research study for any reason, you should contact the principal investigator: Lauren A. Grieco, at: 512-232-6054. You should also call the principal investigator for any questions, concerns, or complaints about the research. You are free to withdraw your consent and stop participation in this research study at any time without penalty or loss of benefits for which you may be entitled. Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study.**

In addition, if you have questions about your child's rights as a research participant, or if you have complaints, concerns, or questions about the research, please contact Jody L. Jensen, Ph.D., Chair, The University of Texas at Austin Institutional Review Board for the Protection of Human Subjects, or the Office of Research Compliance and Support at (512) 471-8871.

Any information that is obtained in connection with this study and that can be identified with your son/daughter will remain confidential and will be disclosed only with your permission. His/her responses will not be linked to his or her name or your name in any written or verbal report of this research project.

Your decision to allow your son/daughter to participate will not affect your or his/her present or future relationship with The University of Texas at Austin or with Round Rock Independent School District.

*How will the privacy and the confidentiality of your child's research records be protected?*

***All identifying information will be removed from all data sheets. These sheets will be stored in a locked file cabinet within the Exercise and Sport Psychology Laboratory (BEL 849) at the University of Texas at Austin. In addition, no identifying information will be entered into the data file. Instead, participant data will be filed under a random identification number, which will also be used on all electronic data. A master list of participant names and their identification number will be created. This will be maintained in a separate, locked office, along with the keys to the file cabinets containing the stored data in the lab. In addition, children will be tested in such a manner that their data cannot be shared, i.e. using random numbers rather than names and conducting focus groups in a classroom setting with the door closed.***

**You may keep the copy of this consent form.**

If in the unlikely event it becomes necessary for the Institutional Review Board to review your child's research records, then The University of Texas at Austin will protect the confidentiality of those records to the extent permitted by law. The research records will not be released without your consent unless required by law or a court order. The data resulting from your child's participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data will contain no identifying information that could associate you with it, or with your child's participation in any study.

This research project is sponsored (e.g., receives funding from outside UT-Austin) by the National Institutes of Health, and therefore, they will also have the legal right to review your child's research records.

**If the results of this research are published or presented at scientific meetings, your child's identity will not be disclosed.**

**Will the researchers benefit from your child's participation in this study?** At the end of this project, the researchers will discover how physical activity lessons affect behavior and will be able to use this information to tailor future school programs to improve academic performance.

**Signatures:**
**You are making a decision about allowing your son/daughter to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. If you later decide that you wish to withdraw your permission for your son/daughter to participate in the study, simply tell your student's teacher and/or contact Lauren Grieco at 512-232-6054. You may discontinue his/her participation at any time.**

**<u>I grant consent for my child</u> to participate in the study:**

☐ **YES** **NO** ☐

______________________________________________
**Printed Name of Son/Daughter** **Date**

______________________________________________
**Signature of Parent(s) or Legal Guardian** **Date**

# Appendix C – IRB Information

**I.** **<u>Title</u>:** Physically active, academic lessons and on-task behavior in preadolescent children: Effects of intensity

**II.** **<u>Principal Investigator</u>:** Lauren A. Grieco, M.A.

**<u>Co-Investigator</u>:** John B. Bartholomew, Ph.D.

**III.** **<u>Hypothesis, Research Questions, or Goals of the Project</u>**: The present study is designed to assess the effects of physically active, academic lessons of varying intensity, set in game-type format, on the on-task behavior of preadolescent children in the classroom setting.

**IV.** **<u>Background and Significance</u>**: Physically active academic lessons use movement in the teaching of core academic concepts in the classroom. They are designed to increase physical activity among elementary school children without sacrificing academic time. These lessons provide additional periods (10-15 minutes in duration) of moderate-to-vigorous physical activity (MVPA) during the school day. Although the aim of these lessons is to provide exercise opportunities throughout the day, additional benefits have been found to occur.

In-class physical activity programs have shown increased in students' on-task behavior during subsequent lessons. Participation in physically active lessons was found to increase children's on-task behavior following an academic lesson taught through physical activity, compared with a control lesson (Mahar, et al., 2006). These lessons consisted of actions such as students standing up from their desks and mimicking actions of a story, and were not designed to incorporate the teaching or rehearsal of academic material. Subsequent studies have been conducted to expand this study using a parallel concept, but using active lessons that incorporated academic content on material covered on standardized tests. Results indicated that these lessons prevented the steep reduction in time on-task observed following traditional non-active academic lessons, with the magnitude of effect significantly greater in children at-risk and overweight (Grieco, Jowers, & Bartholomew, 2009) and in the afternoon compared with the morning (Grieco, Jowers, & Bartholomew, *under review*).

These protocols both aimed to utilize physical activity at a moderate-to-vigorous level of intensity. However, physical activity was not directly measured in these studies, leaving the actual dose of physical activity unknown. The intensity and volume required to elicit the on-task response requires examination. Accordingly, the present study is designed to assess the effects of physically active, academic lessons of varying intensity on the on-task behavior of preadolescent children in the classroom setting.

## V. Research Method, Design, and Proposed Statistical Analysis

Design

A 2 (time: pre-, post-lesson) x 4 [lesson condition: low to moderate intensity/volume physically active academic game, moderate to high intensity/volume physically active academic game; seated computer game (game control), and traditional seated lesson (physical activity control)] between subjects design will be used to assess percentage of time spent on-task (TOT). TOT will be measured during 15-minute classroom observations both prior to and following each of the four lesson conditions. All observations will be conducted on non-P.E. days, with order of condition presentation randomly assigned by classroom. This method has been shown to be a valid measure in previous studies (Mahar et al., 2006; Grieco, Bartholomew & Jowers, 2009).

Method

Participants

Participants will include 3rd, 4th and 5th grade students (approximately aged 7-12 years) recruited from an elementary school in central Texas. A letter of support has been obtained from the school principal, contingent upon ISD district approval process completion. All participants will be provided with informed consent prior to participation. Parental consent forms will be sent home in student homework/notification folders. Consent forms will include a brief description of the project and contact numbers for further information and will be approved by the University of Texas Institutional Review Board. Teachers will collect consent forms for each of their classrooms. Students will be given a pencil for returning consent forms, regardless of consent status. Students with parental consent to participate in the study will be given assent forms by project staff and asked to sign in their presence, and collected immediately following. Project staff will collect the consent forms and store them in a locked file cabinet in the Exercise and Sport Psychology Laboratory at UT. Only the principal investigator will have access to the file cabinets. Both male and female students will be recruited to participate. No gender preference will be made for participation. Based on previous research with elementary schools, it is anticipated that 50% of the sample of students will be female.

Lessons

The physically active, academic lessons used in this study were developed based on the "Texas I-CAN" program, a large study designed to increase physical activity among children and achieve academic curricular goals through movement in the regular education classroom (as opposed to the physical education class). The lessons require 10-15 minutes of moderate to vigorous physical activity (MVPA) and are similar to other active lessons (Gibson et al., 2008; Mahar et al., 2006). In the original program, lessons covered math, language arts, science, social studies, and health along with general lessons accommodating to any fact-based content. In the original study, teachers were trained to implement these lessons in their classrooms.

However, for the present study, the trained project staff will implement the lessons, rather than the teachers, in order to maintain consistency across classrooms and minimize error in implementation and delivery. Following a review of past lesson logs and pilot work, "Spelling Relay" was found to be the most applicable lesson across grades and therefore selected as the treatment lesson. This lesson consists of students breaking up into lines. Staff will give the students a spelling word based on the word list under study during that week. Upon stating cue, the first child in each line will run to the board, write the first letter of the word, run back to the line, give the chalk or marker to the next student in line, and that student will repeat the protocol. This will be repeated until the first group finishes spelling the assigned word and all members sit down on the floor. At that time the staff will quickly review the spelling attempts with students and inform them of the correct word spelling. This process will be repeated for a 15 minute period. Intensity and volume will be manipulated according to condition. In the low-moderate intensity/volume physical activity (LMPA) condition, students will be divided into fewer lines (so as to take fewer turns per student), instructed to walk to and from the board, and to sit down between turns. In the moderate-vigorous intensity/volume physical activity (MVPA) condition, students will be divided into a greater number of lines (allowing greater opportunities to run to the board), instructed to run to and from the board, and to stand and execute various jumps as they await their next turn. This lesson protocol has been found to elicit appropriate activity levels in concert with condition in pilot work.

### Procedure

### Time On-task Observations

On-task behavior will be assessed through time spent on-task (TOT); measured though Momentary Time Sampling (MTS). In this procedure, members of the research team observe individual children for a duration of five seconds before moving on to another child. This child will, in turn, be observed for the same duration before moving on to another child, and so on. After each participating child in the classroom is observed, the researchers repeat this sequence for the remainder of the observation period. Decisions regarding the length of each observation within a sweep were based on variations in the behavior under study and the number of children to observe. Generally, this falls within 1 to 30 second observations for each child (Harrop & Daniels, 1986). Although it may be expected that longer observations increase accuracy, longer observations can result in missing the behavior in other children within the sweep. In fact, observations of more than 5 seconds were found to be less reliable (Gardenier, MacDonald & Green, 2004). Accordingly, the present observation period will be set at five seconds per child, within a total observation period of 15 minutes. In an effort to maximize the number of observations for each student during the 15 min period, the class will be divided into two sections. With 17-22 students/class, this allows each observer to rotate observations amongst 8-11 students. With 180 observations/15 min period, each student will be observed from 16-22 times. Although this prevents the ability to collect interrater reliability (IRR) during the study, IRR will be measured in separate classrooms at the beginning, middle, and end of the study to ensure that consistent standards are maintained. Our past studies using this procedure have yielded IRR of 90%, 92%, 94%, respectively (Grieco, Bartholomew & Jowers, 2008).

Observations will be conducted during the academic instruction time of 1:15 p.m. to 2:15 p.m. on non-P.E. days. Maintaining this consistent observational time will ensure that the academic subject area remains the same across all classes (and therefore, students). Students will be observed for an interval of 15 minutes prior to commencement of the (a) physically active classroom lesson of low-moderate intensity/volume (b) physically active classroom lesson of moderate-vigorous intensity/volume (c) physically inactive computer lesson and (d) traditional inactive classroom lesson; and again for 15 minutes following completion of each of the aforementioned lessons. Order of lesson condition will be randomly assigned.

Each observer will be provided a class seating chart that indicates which students provided active parental consent and their own assent to participate in the study. On-task and off-task behavior will be coded for each participating student on an observation form. Although all students will participate in the lessons, only students with consent and assent to participate will be observed and their data recorded. On-task behavior is defined as any behavior in which a student is attentive to the teacher or actively engaged in the appropriate task, as assigned by the teacher. Off-task behavior is defined as behavior that does not fall under the specifications of "on-task" behavior. Examples of off-task behavior include a student: gazing off, placing her head on the desk, reading or writing inappropriate or unassigned material, talking to or looking at other students when not part of a given assignment, and leaving the desk without receiving permission from the teacher or teacher's aid. Two observers will be present during each observation period. Each observer will listen to an MP3 file via headphones that signals every fifth second. At the signal, the observer will note the appropriate behavior code and begin observation of the next student. TOT will then be calculated for each student by dividing the number of on-task observations by the total number of observations per student.

<u>Observer Training and Reliability</u>

Observers will be trained in a separate set of elementary classrooms to prevent contamination of the observations. Training centers on viewing, coding, and recording behavior over two weeks prior to commencement of the study, with multiple iterations of observations and discussions involving the research team and classroom teachers. Training will be considered complete when inter-rater reliability (IRR) (as a mean percentage of agreement of on-task and off-task behavior scores among all observers participating in the study) exceeds 90%. This is an effective means of training, as our previous work indicates; IRR following four training sessions was 92%. A three-month, follow-up assessment during the last week of observations indicated that reliability remained high, at 94% (Grieco, Bartholomew & Jowers, 2008).

Physical Activity

Accelerometer data will be collected using Actigraph GT1M accelerometers. These devices are designed to collect data through sampling accelerations in the vertical plane. The sampling interval (epoch) will be set at 10 seconds.

Accelerometers (affixed to a belt, worn over the right hip) will be placed on participants by trained program staff as students enter the classroom from the lunch/recess period (12:00 to 12:30 p.m., depending upon participant grade level) and removed at the end of the school day (2:45 p.m.), at which time accelerometers will be collected and data downloaded. Average activity volume (counts/min/lesson) will be calculated using summed counts during each lesson. Time spent per lesson at various intensity levels (min/lesson) will be calculated using child-specific cut-points (Trost, 2008).

Body Mass Index (BMI)

BMI will be assessed for all participants through measurement of height and weight using a Tanita BWB digital scale and Perspective Enterprises portable stadiometer. An additional measurement will be conducted of ten percent of the sample to ensure equipment accuracy. BMI will then be calculated [weight (kg)/ (height (m))$^2$] and participants assigned to the appropriate weight category for age and sex in accordance with CDC "BMI-for-age" growth charts: underweight: < 5$^{th}$ percentile; normal weight: 5$^{th}$ ≤ 85$^{th}$ percentile; at risk for overweight 85$^{th}$ ≤ 95$^{th}$ percentile; and overweight: ≥ 95$^{th}$ percentile (CDC, 2008).

Statistical Analysis

TOT will be analyzed by a 2 (time: pre-, post-lesson) x 4 [lesson condition: low to moderate intensity/volume physically active academic game, moderate to high intensity/volume physically active academic game; inactive game (game control), and inactive lesson (physical activity control)] repeated measures analysis of variance (RMANOVA). Interactions will be decomposed and analyzed via separate RMANOVAs.

BMI will be analyzed using a 4 (lesson condition) x 3 (BMI category) RMANOVA. The simple effects of interactions will be analyzed with separate RMANOVAs. One-way ANOVA on student enjoyment will be used to determine differences in student enjoyment across lesson conditions. Accelerometer data will serve primarily as a manipulation check per condition, with secondary analyses conducted on activity level and TOT.

## VI. Human Subject Interactions

A. **Sources of potential participants:** The data for this project will be voluntarily provided by all potential participants recruited from an elementary school in central Texas. Participants will include 3$^{rd}$, 4$^{th}$ and 5$^{th}$ grade students (approximately aged 7-12 years) who give assent and whose parents give active consent.

B. **Procedures for the recruitment of the participants** will consist of letters sent home by the teacher in student folders, notifying parents of the study and encouraging participation if they feel that the study is an endeavor that they would like for their child to be a part of. Both male and female students will be recruited to participate. No gender preference will be made for participation. Based on previous research with elementary schools, it is anticipated that 50% of the sample of students will be female.

C. **Procedure for obtaining informed consent**. All participants will be provided with informed consent prior to participation. Students will be given parental consents to take home and return with parental signatures indicating consent status (active consent). Consent forms will include a brief description of the project and contact numbers for further information and will be approved by the University of Texas Institutional Review Board. Teachers will collect consent forms for each of their classrooms. Students with parental consent to participate in the study will be provided with assent forms to participate in the study. Project staff will collect the consent forms and store them in a locked file cabinet in the Exercise and Sport Psychology Laboratory at UT. Only the principal investigator will have access to the file cabinets.

D. **Research Protocol**. This proposal describes a short duration, school-based study that will recruit approximately 300 students with consent and assent in the $3^{rd}$, $4^{th}$ and $5^{th}$ grades as participants. Experimental interactions with children will involve: (1) behavioral assessment through direct observation; (2) objective assessment of physical activity through accelerometers, and (3) measurement of heights and weights.

Behavioral assessment will use Momentary Time Sampling (MTS). In this procedure, members of the research team observe individual children for a duration of five seconds before moving on to another child. This child will, in turn, be observed for the same duration before moving on to another child, and so on. After each participating child in the classroom is observed, the researchers repeat this sequence for the remainder of the observation period. the present observation period will be set at five seconds per child, within a total observation period of 15 minutes. In an effort to maximize the number of observations for each student during the 15 min period, the class will be divided into two sections. With 17-22 students/class, this allows each observer to rotate observations amongst 8-11 students. With 180 observations/15 min period, each student will be observed from 16-22 times. Observations will be conducted during the academic instruction time of 1:15 p.m. to 2:15 p.m. on non-P.E. days. Students will be observed for an interval of 15 minutes prior to commencement of the (a) physically active classroom lesson of low-moderate intensity/volume (b) physically active classroom lesson of moderate-vigorous intensity/volume (c) physically inactive computer lesson and (d) traditional inactive classroom lesson; and again for 15 minutes following completion of each of the aforementioned lessons. Order of lesson condition will be randomly assigned.

Physical activity data will be collected using accelerometers (affixed to a belt, worn over the right hip) will be placed on participants by trained program staff as students enter the classroom from the lunch/recess period (12:00 to 12:30 p.m., depending upon participant grade level) and removed at the end of the school day (2:45 p.m.), at which time accelerometers will be collected and data downloaded. Average activity volume (counts/min/lesson) will be calculated using summed counts during each lesson. Time spent per lesson at various intensity levels (min/lesson) will be calculated using child-specific cut-points (Trost, 2008).

BMI will be assessed for all participants through measurement of height and weight using a Tanita BWB digital scale and Perspective Enterprises portable stadiometer. An additional measurement will be conducted of ten percent of the sample to ensure equipment accuracy.

**E.** The study will take place over the period of a semester. Given the procedures in place to minimize risk, the duration of the trial, and size of the participant pool, this is considered a Phase II clinical trial and does not require an independent Data Safety Monitoring Board. However, given the special concerns regarding consent with child participants, a consent monitor will be present within each school.

**F.** **<u>Privacy and confidentiality of participants</u>**. The risk of exposing an individual's data will be protected by: (1) utilization of unique identification numbers for each participant; (2) storage of the code list linking names to identification numbers in a locked file, separate from any individual data; (3) storage of all raw data in a locked file cabinet; (4) the removal of all identifying information from all raw data prior to entry or storage.

Given the relatively minor threat of psychological discomfort for child participants, the steps taken to reduce the risk should be sufficient to ensure that participation represents a positive experience while minimizing the risks.

**G.** **<u>Confidentiality of the research data.</u>** Participants will not be asked to provide identifying information. Data will be stored in a locked filing cabinet in Bellmont 849 on the UT campus to ensure security and confidentiality.

**H.** **<u>Research resources</u>** are adequate for the study. The PI has prior experience conducting studies of this nature. The study will be conducted in an elementary school during regular school hours, thereby allowing participants all resources available for emergency situations. In addition to review of consent procedures, the PI will be responsible for independently querying teachers for signs of adverse events, including: (1) any child with an expressed discomfort with any of the lessons; (2) injury that occurs during participation in the active lessons; (3) "teasing" from other children regarding participation in the study or from study outcomes. In the case of an adverse event, the PI will report the event to the school principal, within 24 hours of notification, with written back-up. In the event of injury, the teacher will also notify the school nurse. The PI will then be responsible for reporting the adverse event to: (a) The University of Texas Institutional Review Board for Human Subjects (IRB) within 24 hours of notification.

**VII.** **Potential risks.** Possible discomfort may occur if a child feels anxious about being measured for height and weight or wearing an activity monitor. In our previous experience working with children, we have found that because the school nurse measures them for height and weight each year, students are used to being measured. Activity monitors are often a favorite item for children to use and they use them as part of P.E. class in some schools.

Children will be observed during class time by an independent observer. Possible risks include discomfort associated with being observed. However, the observer will not address the children, nor will identities be linked to children. Observers will enter and leave the classroom without disturbing the class, and no disruption is perceived to occur, as children are accustomed to adults entering and departing the room on a regular basis.

Children may become physically injured (minor injuries such as a bruised shin) as a result of participating in the physical activity lessons in class. However, the physical risk is not expected to be more than any risk a child faces during school recess or P.E. class.

**VIII.** **Potential benefits.** There are no direct benefits to the student participants. However, there are clear potential benefits to society at large for enhancing education and health related outcomes. This intervention represents an attempt to increase physical activity and improve on-task behavior in children. The resulting data will indicate both the individual and relative benefit of the physically active, academic lessons for behavioral control, thereby enabling schools to select curricula apropos of increasing learning and academic performance among students. Furthermore, the inclusion of 10-15 minutes of additional activity during the school day aids children in obtaining the physical activity recommendations for health benefits.

**IX.** **Sites or agencies involved in the research project.** Data will be collected at Forest Creek Elementary School in Round Rock, TX. A letter of support from the school principal is attached.

**X.** **Review by another IRB**: N/A

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Appendix D – Student Assent Form

**ASSENT FORM**
***Physically Active, Academic Lessons and On-task Behavior in Preadolescent Children: Effects of Intensity***

I agree to be in a study about children and physical activity. My parents explained the study to me and they said I could be in it. The only people who will know what I say and do will be the people in charge of the study.

I know that as a part of the study I will wear a little box on my waist that will measure the amount of my physical activity and observed during class.

Writing my name on this page means that the page was read to me and that I agree to be in the study. I know what will happen to me. I can stop the study at any time if I want to and I will not get into trouble. If I want to stop, all I need to do is tell my teacher or the person in charge.

Print your name here:
______________________________________________________

Sign your name here:
______________________________________________________

Date: _____________

Investigator's signature here:
________________________________________________________

Date: ______________

TEXAS
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Initiatives for Children's Activity and Nutrition

# Spelling Relay

**Equipment:** Whiteboard/chalkboard and markers/chalk

**Procedure:**
- Students are divided into 6 lines
- Groups stand at one end of playing area opposite the board.
- Investigator calls out a word, uses it in a sentence and states the word again.
- First student in each line runs (or other given activity*) to the board and writes the first letter of word.
- Each subsequent team member completes this sequence until the word is spelled while students in line continue activities instructed activities out in place.
- Upon word completion, students in the corresponding team sit down to signal activity completion.
- Words are reviewed with the class and procedure is repeated for the 15 min. period.

***Activities**:
*While waiting for turn*: Jumping jacks, star jumps, ski jumps, scissor jumps, sit-ups, bridge, push-ups, running in place, quick feet, hop on one foot/other foot
*En route to board*: Jog, run, hop, grapevine

TEXAS i-Can! Initiatives for Children's Activity and Nutrition

# Spelling Relay

**Equipment:** Whiteboard/chalkboard and markers/chalk

**Procedure:**
- Students are divided into 4 lines
- Groups stand at one end of playing area opposite the board.
- Investigator calls out a word, uses it in a sentence and states the word again.
- First student in each line runs (or other given activity*) to the board and writes the first letter of word.
- Each subsequent team member completes this sequence until the word is spelled while students in line continue activities instructed activities out in place.
- Upon word completion, students in the corresponding team sit down to signal activity completion.
- Words are reviewed with the class and procedure is repeated for the 15 min. period.

***Activities**:
*While waiting for turn*: sit-ups, push-ups, jogging in place, hop on one foot/other foot
*En route to board*: Walk, walk backwards, side step;

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# Seated Spelling Relay

**Equipment:** Paper, writing utensil

**Procedure:**

- Students sit at their desks arranged in groups of four
- Investigator calls out a word, uses it in a sentence and states the word again.
- First student in each group writes the first letter of word then passes it to the next student. This child writes the next letter of the word and passes it on to the next student.
- Each subsequent team member completes this sequence until the word is spelled.
- Upon word completion, students in the corresponding team puts their writing implement on the table to signal activity completion.
- Words are reviewed with the class and procedure is repeated for the 15 min. period.

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# Pyramid Spelling

**Equipment:** Paper, writing utensil

**Procedure:**

- Students are seated at their desks in silence
- Investigator calls out a word, uses it in a sentence and states the word again.
- Each student writes the word as exemplified below.*
- Students complete this sequence until the word is spelled
- Upon word completion, students remove a letter from each line
- Words are reviewed with the class and procedure is repeated for the 15 min. period.

*Example using the word "style:" *(The following would appear on the students' paper, if activity properly executed.)*

*style*

*tyle*

*yle*

*le*

*e*

*le*

*yle*

*tyle*

# Appendix I – Sample Class Sheet

**Teacher Name:**
**Observer Names:**
**Date: 2/10/11**
**Time: 1:15 p.m.**

| Student First | Student Last | Student ID | Consent Returned? | Consent Details | Assent Collected | Assent Details | Accel # | Obs. # | Notes |
|---|---|---|---|---|---|---|---|---|---|
| F. Name | L. Name | XXXXX | yes | 1 | yes | 1 | 1000 | 1 | |
| F. Name | L. Name | XXXXX | yes | 1 | yes | 1 | 1001 | 2 | |
| F. Name | L. Name | N/A | no | 99 | N/A | 0 | N/A | N/A | |
| F. Name | L. Name | XXXXX | yes | 1 | yes | 1 | 1002 | 3 | |
| F. Name | L. Name | XXXXX | yes | 1 | yes | 1 | 1003 | 4 | |
| F. Name | L. Name | XXXXX | yes | 1 | yes | 1 | 1004 | 5 | |
| F. Name | L. Name | XXXXX | yes | 1 | yes | 0 | N/A | N/A | No assent |
| F. Name | L. Name | XXXXX | yes | 1 | yes | 0 | N/A | N/A | No assent |

*"Consent Details" Codes: 1=yes 0=no 99=not received*

*"Assent Details" Codes:1=yes 0=no*

*Students without parental consent were included on the roster to ensure they did not receive assent forms or observation numbers.*

# Appendix J –Observation Sheet

TOT OBSERVATION SHEET

Observation (Circle): Pre- OR Post-
Date:_____________________
Time:_____________________
Teacher:___________________
Observer Names: 1) _____________________
2)_____________________

*Instructions: Sketch layout of classroom and note student # and location.*
*Complete 5 s observation of each student and record as:*
**0 =On-task**
**1 =Off-task**
**X = student leaves classroom**

NOTES:

# Appendix K – Example Completed Observation Sheet

TOT OBSERVATION SHEET

Observation (Circle): Pre- OR Post-
Date: 1/24/11
Time: 1:45 p.m.
Teacher: Brown
Observer Names: 1) David Jones
2) Shelly Smith

*Instructions: Sketch layout of classroom and note student # and location.*
*Complete 5 s observation of each student and record as:*
**0 =On-task**
**1 =Off-task**
**X = student leaves classroom**

NOTES:

5
01111
11100
11101
00111
11000

01111
11100
11101
00011
11111

8
01111
11100
11101
00111
11111

18
Observer 2

01111
11111
11101
00111
11111

13
Observer 2

14
Observer 2

15
Observer 2

17
01111
00000
11101
00111
11111

1
11111
11100
11111
00111
11111

6

12
Observer 2

9
Observer 2

11
Observer 2

10
Observer 2

16
01111
11100
11101
00111
11111

3
01111
11100
11101
00111
11111

2
01111
11100
11101
11111
11111

4
01111
11100
11111
00111
1111X

7
01111
11100
11101
00111
11111

Observer 2

**Appendix L – Situational Interest Survey**

*Directions: Please answer the following question based on the lesson just completed.*

How much did you like the activity in which you just participated?

A lot | A little | Sort of | Not really | Not at all

Name/#: ____________________________________________

Teacher Name: _____________________________________

**To be administered post- 2nd TOT observation, in all conditio*

# Appendix M – Example Post-observation Sheet

**Teacher Name:**

**Observer Names:**

**Date: 2/10/11**

**Time: 1:15 p.m.**

| | | | | | | Pre-lesson TOT | | Post-lesson TOT | |
|---|---|---|---|---|---|---|---|---|---|
| **Student First** | **Student Last** | **Student ID** | **Accel #** | **Obs. #** | **Situational Interest** | **# On-task** | **Total # Obs.** | **# On-task** | **Total # Obs.** |
| F. Name | L. Name | XXXXX | 1000 | 1 | 3 | 13 | 20 | 13 | 19 |
| F. Name | L. Name | XXXXX | 1001 | 2 | 2 | 12 | 20 | 13 | 19 |
| F. Name | L. Name | XXXXX | 1002 | 3 | 4 | 17 | 20 | 14 | 20 |
| F. Name | L. Name | XXXXX | 1003 | 4 | 4 | 15 | 20 | 15 | 20 |
| F. Name | L. Name | XXXXX | 1004 | 5 | 4 | 18 | 19 | 7 | 19 |
| F. Name | L. Name | XXXXX | 1005 | 8 | 3 | 14 | 19 | 10 | 19 |
| F. Name | L. Name | XXXXX | 1006 | 9 | 5 | 13 | 19 | 18 | 19 |

**Completed (for participating students only) by observers following experimental protocol.*

*TOT observation data from the seating chart observation sheets and responses on enjoyment surveys were transferred to this form.*

Appendix N – MET Range and Activity Count Cut-points by Intensity Category

| ***Intensity Category*** | ***MET Range*** | ***Counts/minute*** |
|---|---|---|
| Sedentary | 1 to 1.5 | <100 |
| Light | 1.5 to 3 | ≥ 100 to < 1703 |
| Moderate | 3 to 6 | ≥ 1703 to < 4252 |
| Vigorous | 6 to 9 | ≥ 4252 |
| LMPA | 1.5 to 6 | ≥ 100 to < 4252 |
| MVPA | ≥ 3 | ≥ 1703 |

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